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American Society of Sugar Cane Technologists

Volume 7A - Papers for 1957 - 1958

March, 1963

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American Society of Sugar Cane Technologists

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FOREWORD

This is part A of the seventh volume of proceedings of the Society which have been published since its founding in 1938.

The first volume published in 1941 included papers presented during 1938, 1939 and 1940. Mr. Walter Godchaux, Jr., the then Secretary-Treasurer, edited that edition.

The second volume published in 1946 included papers presented during 1941-1945 inclusive. Dr. E. V. Abbott, Secretary-Treasurer, edited that edition.

The third volume published in 1953 included papers presented during 1946-1950 inclusive. A fourth volume was published in 1955 and presented papers for the years of 1950 through 1953. Volume five contains papers for the years of 1954 and 1955. The sixth volume included papers presented during 1956. The third through sixth volumes were edited by Dr. Arthur G. Keller.

This volume 7A includes papers for the years 1957 and 1958 and has been compiled by the writer.

Denver T. Loupe
Secretary-Treasurer

March 1963

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A CONSULTANT SERVICE TO PROVIDE SUPERVISED CONTROL OF THE SUGAR CANE BORER AND OTHER CANE INSECTS

A. L. Dugas, Entomologist
Dugas Pest Control Laboratories

Supervised control, which essentially means the supervision of insect control by an unbiased professional Entomologist, is a relatively new service in Agriculture, and has originated from the increased demands of farmers upon research workers for this type of service. The development of this service has been rapid in some states and is now becoming firmly established in the cotton and sugar cane growing areas of Louisiana.

It has been evident for several years that there was a great need, in the sugar cane industry, for a consultant service administered by scientifically trained personnel, to provide supervised control of the sugar cane borer and other insects attacking sugar cane. It appears that this service should be flexible enough to include other farm practices when the need becomes justified.

The principal aim of this particular consultant organization is to tailor control recommendations to individual areas of a sugarcane farm or plantation, rather than to give broad general recommendations which cannot consider local factors. All phases of control, not just chemical, are applied and integrated, with cultural practices and beneficial insects given proper consideration. Savings are realized from significantly better control at the lowest possible cost.

This paper presents a brief description of the service of supervised control of sugar cane insects, the need of the service in the sugar industry, the organization rendering the consultant program, the services rendered, and the advantages resulting from its operation. It is impossible to consider all of the farms or plantations under supervision; although that would be desirable, for the circumstances differ in varying degrees in each separate case. So reference is made to only one, that of Laurel Valley Plantation, managed by Mr. Wilson Lepine, to illustrate the basic organization and operation.

Needs of Supervised Control

There were many reasons for the need of supervised control in the sugar cane area. The following are only a few:

1. Insect conditions vary considerably from one area to the other on the same farm and more so on one particular farm as compared to another. So in many instances broad or general recommendations are not applicable.

2. There is a lack of trained personnel on many farms, without the know-how and experience necessary to supervise such a program.

3. Insecticides and other pesticides are expensive and should be used correctly or not at all. Without a doubt their proper use is necessary if maximum yields are to be realized.

4. Dependence of the growers upon research personnel for this service had reached unjustifiable limits.

5. Research workers do not have sufficient time to visit any

number of farms even once, and certainly not often enough to make the necessary weekly observations which are so essential. The farmer, therefore, loses certain benefits of this type of control program. At the same time, the research program must suffer at the expense of furnishing such assistance as is possible to give.

6. To have to decide upon a borer control program at the very beginning of the infestation is most difficult and has many disadvantages. Recommendations refined each week according to extent and level of current borer infestation, variety of cane, soil type, stage and condition of cane growth, fertilization, cropping system and weather conditions, are so much more applicable.

7. Finally, the promiscuous application of insecticides, without regard to whether they are needed, is highly undesirable both from the standpoints of building up resistance in certain species of insects and in upsetting the balance of nature, thereby creating serious problems of insects previously of no economic importance. Of no less importance is the matter of expenditures for unnecessary applications, resulting in a higher cost of insect control.

Organization of Consultant Service

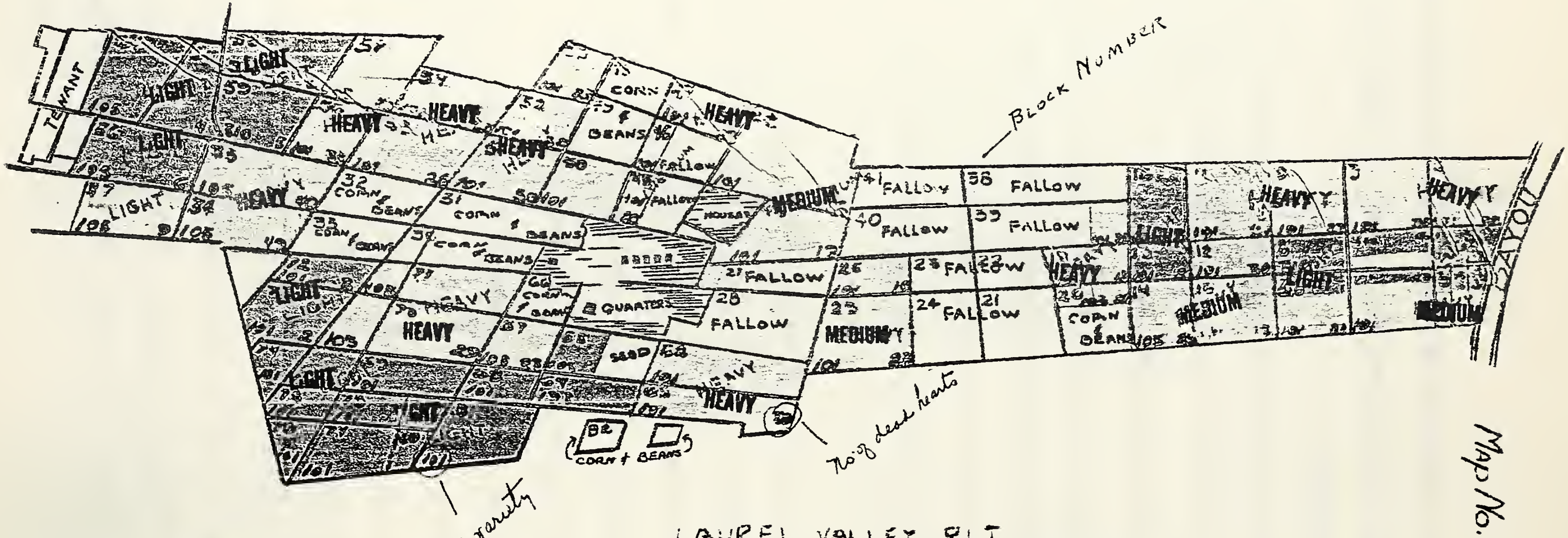
In order to tailor control recommendations to individual areas of certain farms or plantations, the first requisite appeared to be a relatively simple but accurate map of the place, outlining the bean, corn, fallow, and cane areas, with a further breakdown of plant and stubble cane and the different varieties. This is actually an attempt to eliminate the impossible task of having to deal with the smallest division, referred to as a cut, and to consider areas of blocks of stubble and plant cane of various varieties.

The large aerial photograph of the farms or plantations under contract were studied as a possible basic map. These were reduced to the size of a legal size sheet, and a tracing was made of the reduced map omitting the cut divisions, thereby showing only blocks, consisting of many cuts and separated by roads or canals. Blue line prints were then made of the tracing to furnish the number of maps needed for submitting weekly recommendations and other significant data. (See Map No. 1).

In conference with the owner or field men, into each area of the maps were recorded the existing crop, as to variety of cane, plant or stubble, beans, corn, or fallow ground. For easier identification, the plant cane blocks were colored in red and the stubble in green. This provided a map with all the necessary information to facilitate as thorough a checking as possible, without loss of time, and on which to present the specific recommendations pertaining to each particular area. Proper consideration was given to the use of these maps by the pilots in insecticidal applications on specific areas without having to flag the fields for identification.

The personnel to provide this service consisted of a field crew of four college students trained to make the necessary counts and observations, the author or consultant, and a secretary. One field man was assigned to each of four areas, designated as the Upper Mississippi,

WEEK OF: June 10, 1956
GENERATION OF BORERS: First
DEADHEART COUNT: Number of deadhearts per 200 row feet, and average level of infestation.



LAUREL VALLEY PLT.
J. WILSON LEPINE OWNER

Map No. 1

PLANT ▆
STUBBLE ▨

Lower Mississippi, Bayou Lafourche, and Teche areas. The farms accepted for consultant service in each of the areas were partially selected for nearness to each other to expedite traveling to and from each place. The field man in each area was required to cover all of his acreage at least once a week or more alone and then again with the consultant just before weekly recommendations were made. A map with the recommendations was given the grower each week before leaving the farm. The secretary assisted in the preparation of reports and maps.

Services Rendered

The services rendered were planned with an idea of integrating chemical, biological and cultural practices in a borer control program. Foremost in mind, was to effect the best control obtainable, and at the same time to maintain the cost at the lowest possible level.

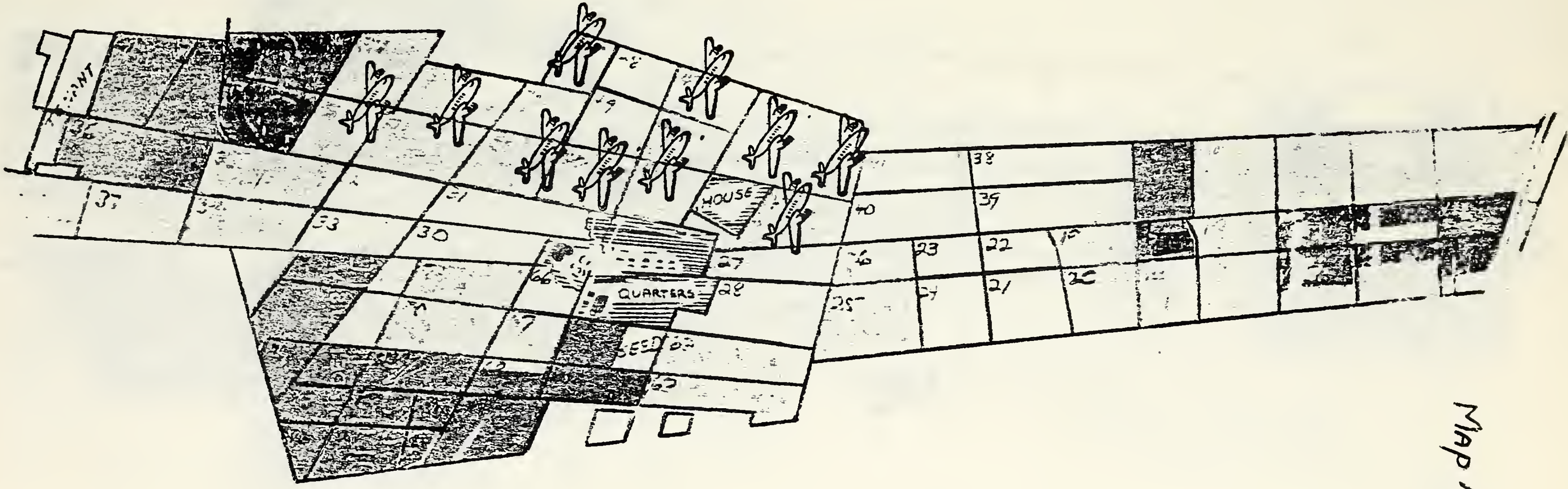
To begin with, a first-generation survey was made in early June to determine location, level, and extent of the borer infestation as a basis for further planning of the chemical and parasite phases of the program and for estimating insecticide and application needs. The number of deadhearts per 200 row feet was used as a measure of infestation, and a map referred to as Map No. 1, to present the results was prepared for each farm and submitted to the grower. An examination of this map reveals that the block number was placed in the upper left hand corner of each block; the variety of cane as 101, 310, 105, etc., in the lower left; and the number of deadhearts per 200 row feet in the lower right of each block in which the count was made. For easier interpretation, light, medium, and heavy classifications of infestation were designated to various areas of the farm.

After establishing a picture of the first generation infestation, weekly surveys were made thereafter, in June, July, and August, to maintain a constant check on borer development for controlling the second and third generations of borers through the use of insecticides and parasites. Recommendations were made each week by the consultant as to time to start applications in individual areas of the farm or plantation, whether an application should be used for that week, and dosage rates determined according to level and development of infestation. Weekly maps were submitted showing the areas to be dusted for that week as indicated by an airplane stamped in the area. The dosage rate recommended was based on borer conditions at the time, and critical areas were outlined for special attention in order to bring them back in line. Either general or concentrated Trichogramma parasite releases were recommended according to the level and location of borer eggs.

Maps No. 2, 3, and 4 are copies of the maps presenting the recommendations for different weeks on Laurel Valley. These do not necessarily represent any sort of average recommendations, since there was little likeness between one farm and another. However, an analysis of the set of recommendations for Laurel Valley gives one an idea of the general nature of those for other places. No dusting was recommended until the week of July 1, because of the slow borer development due to

Map No. 2

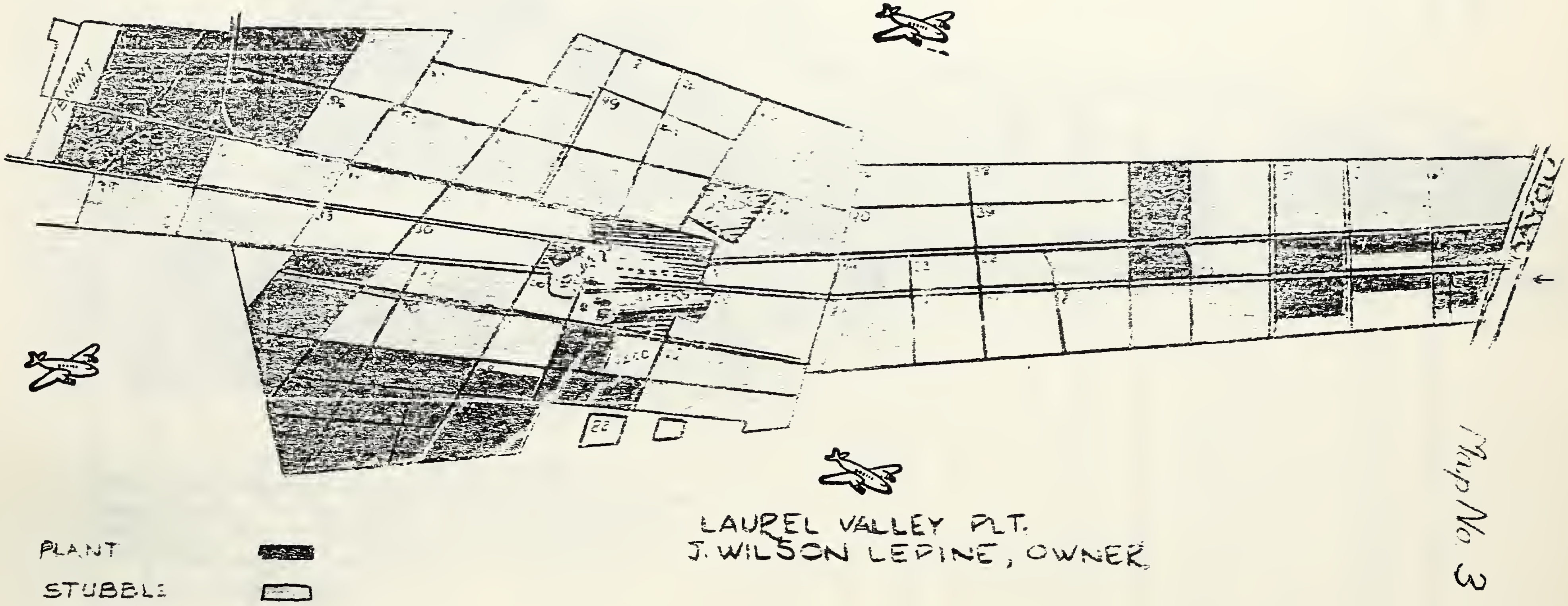
WEEK OF: July 1, 1956
GENERATION OF BORERS: Second
ACREAGE TO DUST: Areas designated by airplanes
APPLICATION RATE: 12 lbs. per acre per application
REMARKS: Concentrate Trichogramma parasite release in variety C.P. 44-101 stubble.



LAUREL VALLEY PLT.
J. WILSON LEPINE, OWNER

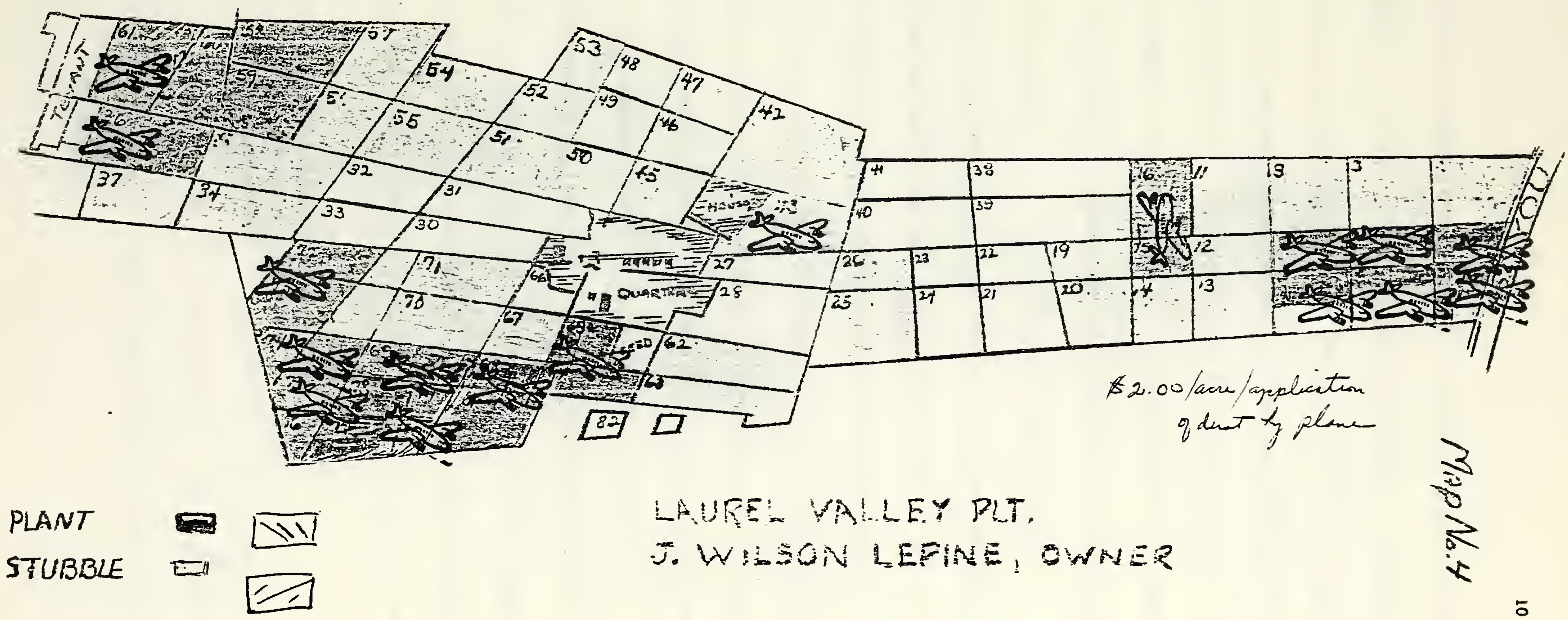
PLANT ■
STUBBLE ▨

WEEK OF July 8, 1956
GENERATION OF BORERS: Second
ACREAGE TO DUST: Dust all cane acreage
APPLICATION RATE: 12 lbs. per acre per application
REMARKS: Control is very good but considerable new hatch out of borers. Concentrate Trichogramma parasite releases in plant cane.



Map No. 3

WEEK OF: July 15, 1956
GENERATION OF BORERS: Second
ACREAGE TO DUST: Areas designated by airplanes
APPLICATION RATE: 12 lbs. per acre per application
REMARKS: Control is very good on entire place.
New hatch-out concentrated in plant cane.



$2.00/acre/application
of dust by plane

LAUREL VALLEY PLT.
J. WILSON LEPINE, OWNER

Map No. 4

light rainfall, Map No. 2 shows only about one-third of the cane needed treatment. Map No. 3 for the week of July 8, reveals that dusting was recommended for all cane acreage because of a general hatchout of borers. Trichogramma parasite releases were directed to the plant cane. Map No. 4 for the week of July 15 reveals the recommendation of dusting little more than the plant cane. No more dusting either for the second or third generation was found to be necessary on this farm.

On Map No. 5 is a report of a borer infestation count to determine the degree of control after the dusting period. The plantation average of only .64 per cent of the joints bored indicated excellent control.

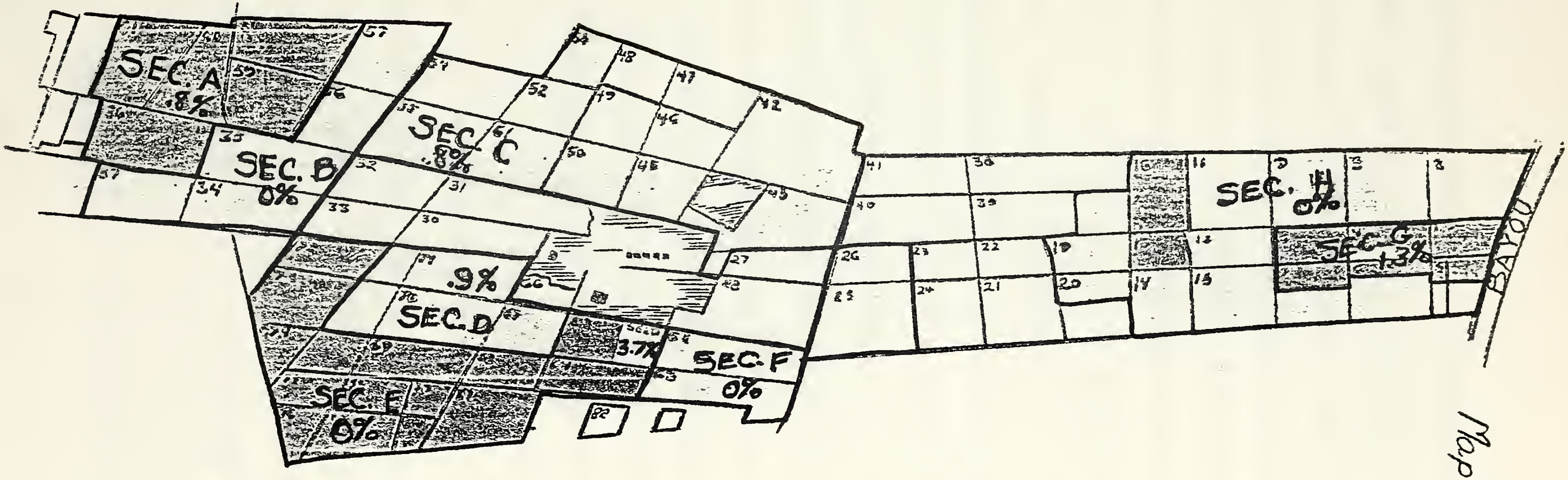
A somewhat limited harvesttime survey was made to determine fields with heaviest borer infestation and carryover so as to make specific recommendations regarding harvesting for preventing further losses and application of cultural practices for destroying overwintering populations.

In addition to the borer problem, assistance was given on control of soil insects of sugar cane, as well as in determining the amount of damage and losses resulting from soil insects in individual areas of a respective farm. Help was also rendered in the control of corn insects, treating of seed corn, soybean insects, and other problems.

Advantages Resulting from the Service

After a year of operation, there were found to be many advantages of the consultant service to the grower. In any one year, the gains from the use of the service vary a great deal on one farm as compared to

WEEK OF: *August 12, 1956*
GENERATION OF BORER: *Third*
BORER INFESTATION COUNT: *Per cent joints bored in various areas*
PLANTATION AVERAGE: *.64% joints bored*



Map No. 5

PLANT ▆
STUBBLE ▒

LAUREL VALLEY PLT.
J. WILSON LEPINE, OWNER

another, depending upon the borer conditions prevailing throughout the season. Over a period of years the advantages should become more closely related on all farms. The following are only some of the advantages:

1. The consultant Entomologist worked solely in the farmers behalf, selling knowledge, services, and information. He represented no commercial insecticide or plane company relative to the sale of pesticides or application of such.

2. The usual pressure put on the growers by the plane operators to start applications in order to finish and move to cotton was eliminated through a firm understanding that no dusting would be started until the proper time. The quality of airplane application improved materially with the continuous checking each week behind the operators.

3. The grower was relieved of the usual uncertainty and worry attached to pest control relative to proper timing and lack of detailed scientific knowledge which is so necessary. He had at his disposal the latest developments on insect control and an understanding of the complications involved.

4. Borer control was made significantly more effective because of the integrated program of cultural, parasite and chemical practices. Because of the more effective control with a corresponding decrease in pieces of cane left in the fields and in number of borers entering hibernation, definite progress was made in a progressive reduction of borer infestation for another year and prospects of a potentially lower cost of control, especially in respect to dusting needs.

5. Certain benefits were received from the supervised use of cultural practices, and observations on susceptibility of different varieties. Varieties N.Co. 310 and C.P. 43-9 were found to exhibit a distinct resistance on all farms, and were rightfully omitted from the dusting program.

6. The chemical phase was by far the most effective of any year, and at the same time most economical. Some of the contributing factors were as follows:

a. Timing of applications was improved considerably. Applications were not started in any areas of any place until borer development justified it. Better use was thereby made of all applications.

b. The difficulty of having to decide upon the whole dusting program prior to starting applications was eliminated in favor of weekly recommendations based upon current borer conditions.

c. Unnecessary applications were eliminated. The number of applications used was governed by actual weekly conditions.

d. The control period covered both the second and third generations, extending it nearer to harvest. Some areas or whole farms needed no third generation dusting. Others required more third than second.

e. Dosage rates were based on specific borer conditions in each area.

f. Areas where borer infestations were heaviest and where control was falling behind, were outlined by a red line as critical areas for any particular week. Heavier or double applications brought such areas back in line with the overall level of control.

g. Growers other than the ones using the consultant service also profited by following more specific recommendations for farms serviced in their vicinity.

h. Control of the total insect population in an area was attained, since a large number of all fields needing control measure were treated at the correct time; thereby, preventing a general buildup and spread.

7. Usefulness of Trichogramma parasites was improved by directing concentrated releases to areas where borer eggs were most plentiful. More general establishment and a rapid buildup to as high as 65 per cent parasitism the first week of July were observed. In general, on farms where a high parasitism prevailed early in the season, no third generation dusting was justified and bored joints at the top of the stalks were noticeably light.

Although the very encouraging results of the first year of operation of the consultant service firmly established the need for and the advantages of supervised control of sugar cane insects in the Louisiana cane industry, no claim is made that there is no room for improvement. Plans are under way to improve the organization and the services to be rendered another year.

EXPERIMENTS ON THE HAWAIIAN BUNCH METHOD AT LOUISIANA AGRICULTURAL EXPERIMENT STATION

R. D. Breaux, P. H. Dunckelman and S. J. P. Chilton

Introduction

Established breeding programs of the different sugar producing countries of the world produce and evaluate thousands and in some cases millions of sugarcane seedlings annually in an effort to select varieties that better meet the particular requirements of their industries. It is understandable that different selection criteria must be employed in the different countries. Techniques of crossing and selection employed at different stations are just as varied.

Hawaiian breeders have evolved a philosophy (1) based primarily upon providing a very wide base of parental material to insure maximum genetic variation in seedling populations. With the use of "metling pot" and "area" crosses the Hawaiian breeders were able to accomplish a large number of crosses and produce large numbers of seedlings annually. A "bunch planting" method was adopted to accommodate three hundreds of thousands of seedlings. It consists simply of planting 5 to 15 seedlings in a bunch spaced 12 to 24 inches apart rather than a single seedling so spaced. The Hawaiians refer to their philosophy as the "extensive" approach and believe that revision of their program towards these extensive procedures "that is, a broader genetic base, more parental combinations, and larger seedling populations may realize more returns per dollar invested in the breeding program."

Single space-planted seedling populations from bi-parental crosses have been employed almost exclusively in the breeding program for the Louisiana sugarcane industry. Improved crossing techniques at Canal Point and the addition of a second seed source at Baton Rouge, Louisiana (2) have increased the number of seedlings available to the program. It is now quite conceivable that more seedlings may be available each year than can be handled by the conventional method. Studies have been initiated at both the Houma and Baton Rouge stations to attempt to evaluate the Hawaiian method of seedling propagation and selection in Louisiana. It is the purpose of this paper to report on progress made at Baton Rouge, Louisiana in this direction.

Materials and Methods

In the spring of 1954, 9,540 Bunch planted seedlings were planted to the field at L.S.U. However, no selections were made from these bunches and they were destroyed in the Fall of 1955. 34,250 seedlings from the 1955 Canal Point series and 5,190 seedlings from the 1955 La. series were planted to the field in bunches of approximately 10 seedlings each in the spring of 1955.

These approximately 40,000 seedlings occupy a single square of land of about 1.3 acres. Planted by the conventional method 40,000 seedlings would occupy approximately 12 to 13 acres, more than the entire amount of land that was available at the Baton Rouge station for plant cane seedlings this year.

In the spring of 1956, 11,360 seedlings of the La. photoperiod series and 28,870 seedlings of the C.P. series were planted to the field in buches of 10 seedlings each.

In the spring of 1955, 26 crosses were planted to the field as both single stools and in bunches for comparative analyses in the future.

Observations on Competition and Natural Selection within Bunches in the Field

Seedlings were transplanted from flats in the spring of 1955 to a somewhat larger clay pot (3 inches) than those used for transplanting single seedlings (2-1/2 inches). Competition between seedlings in the pots was strong and it appeared as though in many cases a single seedling or only a few began to dominate the bunches before being set to the field. It is probable that this is not desirable as it is not generally felt that effective selection for vigor can be made at this stage of seedling development. In Hawaii seedlings in crowded flats are transplanted when 2 to 3 inches tall into newly sterilized flats each accommodating 30 bunches. These bunches are then set to the field 12 to 24 inches apart. According to Warner (1) the rate of natural selection in bunch planted field nurseries is high and of 40,000 to 100,000 seedlings per acre set to the field an estimated 20,000 to 50,000 per acre reach selectable size 10 to 11 months after being transferred to the field. Because of extreme competition each seedling is rarely represented by more than a single stalk when selected at a year of age.

Several methods to lessen competition in pots immediately suggest themselves; (1) use of larger pots; (2) fewer seedlings per bunch or (3) modifications in methods used in handling seedlings before potting to lessen competition prior to setting to the field.

Use of larger pots immediately poses the problem of greenhouse space available as well as bulkiness and added difficulty encountered in planting to the field. The advantage that the system offers in handling large numbers of seedlings becomes minimized.

The possibility of use of fewer seedlings per bunch is under investigation at the Houma Station at the present time.

Some modifications in handling seedlings before transplanting to pots was tried at Baton Rouge in the spring of 1956. A special effort was made to avoid over-crowding in seedling flats of crosses to be bunch planted. After germination test, fuzz was planted so that a maximum of 300 to 400 seedlings per flat was expected. Seedlings to be bunch planted were allowed to remain in flats with frequent fertilization and clipping a longer period of time (1 to 3 weeks) than usual for single planted seedlings. Each seedling was removed from the flat individually rather than in clumps of 10 to equalize extent of root system of each as much as possible and a very rough sorting as to overall size was made for each bunch.

Apparently the above precautions did lessen competition in pots before setting seedlings to the field. Seedling counts within bunches after becoming established in the field and before appreciable suckering occurred showed that survival in the bunches was improved over 1955. More accurate counts of survival within the bunch will be made later in the growing season and more detailed experiments to evaluate natural elimination in bunched stools are planned for the next growing season.

Evaluation of Effectiveness of Selection in Bunch Planted Seedlings

Each seedling of sugarcane can be considered a different variety. When seedlings are space planted singly to the field each stool represents a different variety and observable differences between stools is the first basis for selection or elimination used by the breeder.

In a single bunch planted stool, however, several varieties may be present and selection or elimination must be based upon observable differences between single stalks in the bunched stools.

We are just beginning to accumulate some basic information on effectiveness of selection in first stubble single stools for various agronomic characters of sugarcane in La. 26 crosses of the 1955 bunch plantings were also planted to the field as singles. 19,050 seedlings of these crosses were bunch planted and 7,998 seedlings single planted. Data can be accumulated that should indicate relative effectiveness of selection for various characters by the two methods at the Baton Rouge Station.

One of the primary objectives of the breeding program at Baton Rouge at present is to select a high sucrose cane such as C.P. 48-103 with wider adaptability and more vigor. Every effort is being made to obtain more high sucrose segregates through selective crossing of high sucrose varieties. With this objective in mind it is important to be able to select as effectively as possible high sucrose variants in seedling populations. Recent work by Hebert (3) indicates that selection in first stubble stools of single space planted seedlings as presently practiced is effective, within limits, in isolating high sucrose canes. It is felt at Baton Rouge that effectiveness of selection of single stalks from bunch plantings for juice quality should be comparable to the conventional method if unrestricted application of the bunch planting system is to be made.

Summary

Increased seed supply has made experimentation with the Hawaiian Bunch Planting system possible in Louisiana. Because of a short growing season selection in seedling populations is begun in first-stubble rather than plant cane as practiced in Hawaii. Experiments to determine extent and direction of natural selection in bunch planted seedlings after two years growth have been inaugurated at the Baton Rouge Station. Effectiveness of selection for various agronomic characters important to the Louisiana industry by this method will also be studied.

1. Warner, J. N. The philosophy of sugarcane breeding in Hawaii. Proceedings of the 8th Congress, International Society of Sugarcane Technologists. pp. 410-415. 1953.

2. Chilton, S. J. P. and C. F. Moreland. Experiments on the flowering of sugarcane. Sugar Bul. 32: 165-169. 1954.

3. Hebert, Leo P. Breeding behavior of certain agronomic characters in progenies of sugarcane crosses. Unpublished Thesis, La. State University, June, 1956.

COMPARISON OF INDICATED SUGAR YIELDS OF IMPORTANT VARIETIES ON DIFFERENT DATES DURING RECENT YEARS AT HOUMA, LOUISIANA

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Field Crops Research Branch, Agricultural Research Service
United States Department of Agriculture

According to preliminary data just reported[1], yields of sugar per ton of cane in Louisiana during 1956 were the highest of any year in the last decade. Several contributing factors have been offered as explanation for this increase in sugar recoveries, among them being the favorable growing season, cultural practices, varieties in cultivation, and the milling of fresh cane, but regardless of the underlying causes the fact remains that Louisiana sugar mills bagged more sugar per ton of cane processed in 1956 than they had in many years.

In an attempt to measure the effect of varieties alone on available sugar in cane, use is made of maturity study data accumulated over a period of 4 years at the Houma station in connection with routine variety evaluation. In these studies several varieties, including important commercial varieties and promising unreleased ones, are planted in a randomized block experiment with 5 replications of each variety. Each block is divided into 18 subplots for purposes of sampling and at the different sampling dates a sufficient number of stalks is taken from each of 3 subplots for a sample of 25 stalks. There are, therefore, five

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[1] Durbin, G. J. Press release January 1957.

25-stalk samples for each variety (one sample from each replication) on each sampling date. The samples are taken on October 1, and at semi-monthly intervals thereafter until December 15 each year. These studies are limited to the plant cane crop since the early cutting may affect stubbling and consequently the maturity of the following stubble crop.

Each year 6 varieties are tested in comparison with C.P. 44/101 which has been used during the past 4 years as the standard variety for determining earliness of maturity. During the period 1953 to 1956, inclusive, 11 varieties were tested but for the purposes of this study only 4 varieties, C.P. 44/101, C.P. 44/155, C.P. 48/103 and N.Co. 310 will be used because they were included in all 4 years.

Yields of sugar per ton of cane were calculated according to the Winter-Carp Geerligs formula from crusher juice analyses for Brix and sucrose, using Arceneaux's simplication.[2] Consideration is given to differences in milling extraction between varieties but for purposes of this study the year to year comparisons for any one variety are valid because the correction factors assigned to a variety remained the same during the four years.

Table 1 gives the indicated yields of 96° sugar per ton of cane for 4 varieties in plant cane on each of 6 dates during the harvest season of 1953 to 1956, inclusive, and Table 2 presents the same information in percent of the comparable yields for C.P. 44/101. An examination of Table 1 shows that at the early part of the harvest seasons of 1953, 1954, and 1956 yields of sugar per ton of cane were considerably higher on each date than on the corresponding date in 1955. The interesting thing, however, is that in the case of C.P. 44/101, and C.P. 48/103, yields of sugar per ton were as high, or higher, at the end of the season in 1955 as on the corresponding dates in 1956. C.P. 44/155 was relatively later in maturing in 1956, being consistently below the average for the 4 years on all dates. Yields of sugar per ton of cane for this variety in 1956 were only slightly above the 1955 yields on the first 2 sample dates and actually below the previous year's yields after November 1. It is of interest to point out that for the most of the harvest season this variety had lower sucrose than C.P. 44/101, which has not always been the case in previous studies. The November freezes no doubt affected the manufacture and accumulation of sugar by the cane plant but all varieties increased in yield of sugar per ton from November 15 to December 15. This table further reveals that, in most cases, available sugar in the juice on each date was slightly lower in 1956 than in either 1953 or 1954 for all varieties except N.Co. 310, and that in the average of all dates yields of sugar per ton were consistently lower for varieties C.P. 44/101, C.P. 44/155 and C.P. 48/103 in 1956 than in 1953 and 1954.

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[2] Arceneaux, G. A simplified method of making theoretical sugar yield calculations in accordance with the Winter-Carp-Geerligs formula. Int. Sug. Jour. 37: 364-365. 1935.

N.Co. 310 behaved differently in 1956, with sucrose yields being generally above average and above corresponding yields for the other 3 years, but there were several exceptions in which yields were lower during the past year than in 1953; for example, on October 1, October 15, and November 1. On all other dates sugar yields for this variety were higher in 1956 than in the other 3 years.

Table 2 presents the results of maturity studies with respect to available sugar in cane at different dates for 3 varieties in relation to comparable yields for C.P. 44/101. The relative yields of sugar of the varieties varies somewhat between years but it is believed that the average of 4 years should give a reliable estimate of relative maturity for the varieties studied. In agreement with results of previous tests yields of sugar per ton of cane for C.P. 48/103 were relatively high and those of N.Co. 310 relatively low at the beginning of the harvest season. In the 4 year average C.P. 48/103 gave 134 percent of the sugar yields of C.P. 44/101 on October 1, and approximately 119 percent on December 15, while corresponding yields for N.Co. 310 were 95 and 102 percent, respectively. Values for C.P. 48/103 ranged from 124 to 151 percent of C.P. 44/101 and those for N.Co. 310 from 90 to 98 percent on October 1. C.P. 44/155 averaged 98 percent of C.P. 44/101 on October 1 for all 4 years, ranging from 92 to 102 percent.

Table 1. Average indicated yields of 96° sugar in pounds per ton of cane for four varieties tested at Houma during the period October 1 to December 15, from 1953 to 1956, inclusive.

Variety and Year	DATE OF SAMPLING						
	October		November		December		
	1	15	1	15	1	15	Ave.
C.P. 44/101							
1953	160.0	173.5	186.0	182.7	205.4	214.1	186.9
1954	139.2	155.9	185.2	194.4	219.3	227.5	186.9
1955	108.9	129.3	169.6	189.7	206.9	213.8	169.7
1956	140.0	163.4	172.9	198.9	200.4	209.5	180.8
Ave.	137.0	155.5	178.4	191.4	208.0	216.2	181.1
C.P. 44/155							
1953	163.0	166.0	199.4	189.2	213.4	228.4	193.2
1954	136.4	143.9	180.0	194.7	220.4	232.8	184.7
1955	109.3	139.4	174.0	197.1	215.2	216.8	175.3
1956	126.6	144.7	165.5	190.2	216.2	214.2	176.2
Ave.	133.8	148.5	179.7	192.8	216.3	223.0	182.4
C.P. 48/103							
1953	197.9	216.6	234.3	231.2	252.7	255.9	231.4
1954	187.1	213.9	228.0	240.9	263.3	269.5	233.7
1955	164.9	195.2	212.7	238.4	260.2	262.9	222.4
1956	184.0	203.1	225.9	235.1	239.5	243.8	221.9
Ave.	183.5	207.2	225.2	236.4	253.9	258.0	227.4
N.Co. 310							
1953	151.3	165.4	193.0	201.6	218.9	217.4	191.3
1954	132.0	149.4	163.3	185.3	212.6	225.0	177.9
1955	97.6	120.4	154.3	175.0	209.6	204.2	160.2
1956	137.1	159.5	191.0	214.8	220.8	231.3	192.4
Ave.	129.5	148.7	175.4	194.2	215.5	219.5	180.5

Table 2. Relative indicated yield of 96° sugar per ton of cane for different varieties at Houma during the period October 1 to December 15, from 1953 to 1956, inclusive

(C.P. 44/101 = 100)

Variety and Year	DATE OF SAMPLING					
	October		November		December	
	1	15	1	15	1	15
C.P. 44/155						
1953	102	96	107	104	104	107
1954	98	92	97	100	101	103
1955	100	108	103	104	104	101
1956	90	89	96	96	108	102
Ave.*	98	95	101	101	104	103
C.P. 48/103						
1953	124	125	126	127	123	120
1954	134	137	123	124	120	118
1955	151	151	125	126	126	123
1956	131	124	131	118	120	116
Ave.*	134	133	126	123	122	119
N.Co. 310						
1953	95	95	104	110	107	102
1954	95	96	88	95	97	99
1955	90	93	91	92	101	96
1956	98	98	111	108	110	110
Ave.*	95	96	98	101	104	102

*Weighted values.

Discussion of Results

Indicated yields of sugar per ton of cane for the 4 varieties in this study were higher at Houma in 1953 and 1954 than in 1956. During the same period actual recoveries by the Louisiana sugar factories were considerably lower in 1953 and 1954 than in 1956, according to factory reports. The reasons for the apparent discrepancy between theoretical yields and actual commercial yields can be explained, it is believed, by: (1) a change in varieties milled commercially. Results of tests show that commercial varieties in Louisiana differ by as much as 8 percent in theoretical yield of sugar per ton with the same sucrose and purity analyses of crusher juice because of differences in juice extraction and in purity drop with complete milling; (2) a change in the manner of handling the cane after cutting. With the emphasis on fresh cane because of losses in sucrose after cutting, factories are getting better quality cane; or (3) a combination of the two factors.

During this period the percentage of the cane acreage in the State devoted to C.P. 44/101 has increased from 20 to approximately 51 percent and that devoted to C.P. 36/105 has decreased from 37 to 19 percent.[3] Because of better milling qualities, resulting in more complete extraction, C.P. 44/101 can be expected to yield approximately 4 percent more sugar per ton of cane than C.P. 36/105 when the two varieties have the same crusher juice analysis. The replacing of C.P. 36/105 with C.P. 44/101, which gives better extraction, and slightly better sucrose and purity values, no doubt accounted for much of the increase in sugar yields in the State. It is of interest to speculate as to what the State yields would have been in 1953 and 1954 if C.P. 44/101 had occupied one-half of the State acreage at that time.

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[3] Hebert, L. P. The Louisiana Sugarcane Variety Census for 1956. Sugar Bul. 34(22): 334-337. 1956.

It is recognized that the milling of fresh cane results in higher sugar yields and mills in general made concerted efforts to reduce the time interval from cutting to processing. There is no doubt that during the past two years the quality of the cane milled was much improved over the previous two years. Many mills now employ supervisors to control the deliveries of cane so that it is received as soon after cutting as possible, thus reducing the accumulation of old cane.

It is believed that these two factors, i.e., replacement of C.P. 36/105 with C.P. 44/101, and the processing of fresher cane, were largely responsible for the fact that commercial sugar recoveries were higher than in the past several years although results of maturity studies at Houma show that in the case of three of the varieties studied indicated yields of sugar per ton of cane were actually lower in 1956 than in either 1953 or 1954.

CAN THE LOUISIANA SUGAR INDUSTRY USE SOME VARIETIES OF CANE THAT LODGE

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American Sugar Cane League

History proves that the Louisiana sugar industry has met and overcome its many problems through the application of hard work and sweat, backed by the strong will of the men who were dedicated to its survival. No single castastrophe since the Civil War has been so great as that which happened in the middle twenties; the near fall of the industry due to a complete deterioration of the noble canes. In 1926, Louisiana produced only 47,000 tons of raw sugar. The State average was 6.8 tons of cane per acre. In 1956, Louisiana produced 431,000 tons of sugar, raw value, with a State average of 23.7 net tons of cane per acre.

The increased production since 1926 has been due to many things but most important is the production of new varieties, tailor made for Louisiana conditions by outstanding sugarcane scientists. The cane breeding, selection, testing, and subsequent release of improved varieties through the cooperative program of the United States Department of Agriculture, Louisiana Agricultural Experimental Station, and the American Sugar Cane League, has supplied the very life blood of this industry.

Sugar cane breeding for Louisiana conditions has not been an easy job. The plant breeders have been confronted with at least two more problems than those confronting the sugar cane breeders in most other countries; namely, a very short growing season and the need for erect varieties. In spite of this, the program over the years has been most successful.

Since 1930, many thousand varieties have been planted and studied for adaptation to Louisiana conditions. Approximately 70,000 separate and distinct varieties are now being planted at the L.S.U. and Houma stations each year. During the past 27 years, 25 varieties have met minimum standards to be released for commercial use. Of this number, about one-half have occupied a substantial acreage in the State. Few of these varieties have enjoyed general soil and area adaptability. Today C.P. 44-101 occupies 53% of the cane acreage in the State.

For a variety to meet with industry approval, it must have certain qualities or characteristics called standards. Standards are determined and set by the Louisiana sugar industry in conference with the scientists of L.S.U. and the U.S.D.A. After the standards are set, the breeding, selection, and testing program attempts to conform to the wishes of the industry. Some of the important standards are: good sucrose content, satisfactory yield, good stubbling ability, some resistance to disease and insects, good keeping quality following cutting or after freezes, early maturity, and erectness for mechanical harvesting.

To expect all these qualities in one variety is to almost expect the impossible. This is very evident to those conducting the selection work after checking many thousand new varieties each year. Because it has been very difficult to find in one variety all the qualities mentioned earlier, one or two standards have been lowered in some instances to allow a variety to be released. This was done only when a variety had special locality adaptation or had other good qualities that could offset the undesirable characteristics. In general, it is fair to say that with the information available at the time of any variety's release, minimum standards were adhered to.

Since the advent of the mechanical harvester, every attempt has been made to closely adhere to the standards set for erectness. It is important to note that C.P. 44-154 was released only for the western area and it was considered borderline for mechanical harvest at the time of its release, and this was pointed out in the release statement. It is also a fact that N.Co. 310 did not lodge to any great extent before its release as evidenced by the fact the release report stated; "in erectness of growth and in diameter of stalks, N.Co. 310 is intermediate between Co. 290 and C.P. 44-101, and in most cases it can be satisfactorily harvested by machine."

Throughout the breeding, selection, and testing program, and since the advent of the mechanical harvester, special emphasis has been given to erectness of varieties suitable for mechanical harvesting. The aim was to select and test erect varieties because the industry wanted erect varieties for the mechanical harvester. Varieties that lodged to any great extent were not considered because they were not acceptable.

The value of the conventional cane harvesters is known to everyone in this industry. It is almost impossible to imagine this industry without these machines.

The recent development of the pick-up attachment for the mechanical harvester could possibly change the whole concept of what constitutes suitable growth habits for cane under Louisiana conditions. Grower acceptance of this apparatus will in time decide this. There were many pick-up attachments in the fields during the 1956 harvesting season, and reports indicate that they did a satisfactory job.

Hurricane Flossy did her share in sponsoring the machines. There were many in the industry who were justifiably concerned over the great amount of wind-downed cane following the storm. Harvesting rates during the first two weeks of grinding were slow in areas affected by the storm, but cane delivery became normal soon thereafter. Harvesting costs were certainly higher.

Not taking into consideration storms, certain varieties of cane have greater tendencies than others to lodge. In general, high yielding varieties lodge more than low yielding varieties. It is also true that more lodging will occur in a given variety as yields increase. It has also been stated that any and all varieties lodge to some extent when yields reach 30 to 35 tons of cane per acre. If this is true, and the industry is not willing or ready to accept a variety that lodges, a ceiling is automatically placed on cane production per acre.

If on the other hand, the industry is ready and willing to accept a variety that lodges, the research workers are anxious to know this.

They are anxious to please the industry. The program must anticipate the future, as breeding, selecting, testing, and then releasing a new cane variety requires 8 to 10 years.

The Farm Machinery Advisory Committee, at its last meeting, recommended that some consideration be given varieties that lodge, providing, of course, these varieties also possess high yielding ability and good sugar content.

Many in the industry have shown their willingness to accept N.Co. 310. Many plan to increase the variety this planting season in spite of its lodging characteristics. N.Co. 310 is not brittle and, therefore, does not break up during harvest.

Two varieties, both possessing lodging tendencies, will be transferred to secondary increase stations this year. One of these, C.P. 51-24, had been discarded earlier because of lodging tendencies. However, the Sub-Committee on Varieties chose to reconsider this variety in view of the industry's acceptance of N.Co. 310.

The cane harvester manufacturers believe that the pick-up attachment will be improved. One cane harvester representative states:

> "The future development of the pick-up attachment will depend almost entirely upon the amount of cane other than erect, which is harvested each year. The only way to perfect any part of the sugar cane harvester is through more or less constant use, making improvements yearly during the harvest season."

He also states:

> "It seems proper to say at this time that the best method of approach for the industry would simply be to increase the amount of N.Co. 310 each year. It would then soon become

> necessary to increase the use of the pick-up devices each year so that the entire impact would not come all at once. If this increase of N.Co. 310 could be properly controlled, it would be comparatively easy to solve the problem without serious loss during any one year."

Another manufacturer of Louisiana cane harvester, states:

> "It has been our outlook during the past few years to direct all of our thinking and designs toward the problem of lodged cane. Several attachments have been developed and worked fairly well under the recent conditions."

The primary aim of the breeding program should continue to be one which will give the industry a high yielding, good sucrose cane, which is suitable for mechanical harvesting.

The development of the pick-up attachment to the cane harvester will now permit the selection of some varieties with greater lodging tendencies than could have been tolerated in the past.

It is logical to expect that if the standard for erectness is lowered, higher yielding varieties can be selected.

The United States Sugar Corporation, Clewiston, Florida, produced 37.94 net tons of cane per acre in 1955. Direct labor costs for cutting cane during that season was $0.679 per ton of net cane. In 1956, the United States Sugar Corporation produced an average yield of 44.5 tons of cane per acre with a total production of 941,841 tons of cane. These yields were produced with varieties that lodge.

In the writer's opinion, it will be very difficult to develop a variety for Louisiana which will produce more than 35 tons of cane per acre State average, without substantial lodging. Since economic factors will probably make it necessary that Louisiana produce much higher yields in the future, it appears that growers must accept varieties which lodge to some extent.

A NEW METHOD OF HANDLING LOOSE CANE IN LOUISIANA

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Gulf States Land and Industries, Inc., Raceland Factory

In 1956 Gulf States Land and Industries, Inc., put into operation at their Raceland properties, an idea developed several years ago, which had as its aim reducing cost and increasing speed and efficiency of the harvest both in the field and on the Mill yard.

Prior to this plan Raceland administration cane was hauled directly from the fields in a conventional manner to the factory and stored for grinding at night.

This entailed fixing and tying slings in the field, hooking and tripping slings at the factory, unhooking and reloading slings into the carts before going back to the fields for reloading. The cane from the Napoleonville properties was handled in the field in the same manner and shipped to the Raceland Factory by rail and held in storage for night grinding.

The new operation required changes in the field hauling equipment as well as yard unloading and Mill feeding facilities.

Field wagons were modified by raising sides and ends 18" higher than the conventional wagons. A net made of four chains was permanently attached to the right side of each wagon. This net extended down the right side, across the bottom, and up the left side of the wagon in the same manner in which conventional slings are arranged for field loading. The net is attached to a pipe or bar on the outer left side of the wagon and fits into two sockets on both ends of the cane cart. The dragline operator hooks the bar, raises the load, dumps and returns the net and the bar to its proper position for reloading. The factory grab then moves the cane from the pit to either storage or to feeder table for immediate grinding.

This new operation of handling Raceland administration cane saved 113 man hours per day. This amounted to a savings of 7648 man hours during the 1956 grinding season. In addition to the savings in labor, this operation also made it possible to harvest the crop with a smaller total labor force, in spite of Hurricane Flossy. This alone is an added comfort since scarcity of labor becomes more pressing each year.

Changes in the Napoleonville operation were limited to transporting cane from the field derricks to the Raceland Factory. Ten dump type trailer bodies were designed and constructed for this purpose. The trailer beds measure 36' in length and 8' in width. Three box type compartments each measuring 12' x 8' x 8'4" are hinged to the right side of the trailer bed. Each compartment contains a full length door hinged at the top of the right side of each compartment. Each door has two latches operated from the left side to insure safety.

An effort was made at the Napoleonville properties to load field wagons to 12' length bundles to fit into the compartments. The 12' length loads were lifted from the tractor wagons in slings by a dragline and was either loaded loose in the compartments for immediate shipment or was stored in slings for shipping in the same manner at night.

Upon arrival at the Mill yard at Raceland the cane was handled in the following manner. For grinding immediately, the cane was dumped from the compartments into a pit and picked up by the factory tower grab and placed on feeder tables. For other than immediate grinding, the compartments were dumped by a dragline into a pit and stored by derrick grabs.

At the beginning of grinding much difficulty was encountered in dumping cane from the compartments. However, with modification of the door and with experience and time, unloading conditions were improved although not entirely satisfactory. Plans are being considered to further modify the doors so that the top hinged cross member will in no way interfere with dumping of the cane. This method of handling the cane of the Napoleonville properties afforded savings in labor, freight costs, and in efficiency.

With this new method of handling loose cane in side-dump trucks, the switch Locomotive at Raceland was not used and the scrapping of cane on the tracks was completely eliminated. This operation plus other revisions at the cane shed affected a further saving in the cost of operation.

Cost figures indicate that a substantial saving in freight was realized as well as the receipt of fresher cane which contributed to greater efficiency in the yard and in mill operation generally. The grinding of fresher cane contributed in no small measure to an increased recovery of sugar realized.

Compartment type delivery trucks was not only unique in appearance, but also made travel on the highway comparatively safer than the conventional method of truck hauling.

Acknowledgement is given Mr. Charles A. Wainwright, Chief Engineer and his Staff for designing and engineering the new operation. Without this valuable assistance much less would have been accomplished.

Acknowledgement is also advanced Mr. Russel Ramp, U.S.D.A., Houma Station, for his valuable assistance and interest in the project.

From experience gained during the 1956 harvesting season, the industry should seriously consider both the Tractor Chain-net method of dumping as discussed, as well as the compartment dump type Truck method. Consideration should also be given to the conversion of conventional type truck-trailers to the Chain-net method of dumping. It is felt that the conventional truck trailer can be converted at a reasonable cost.

PRESENT OUTLOOK IN SUGARCANE INSECT RESEARCH

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Many insects and related animals compete with us each year for Louisiana's sugarcane crop. Several of these pests are well known and the injury they inflict is often apparent. Many others may go unnoticed because of their small size, small numbers or secluded habits. No attempt will be made here to mention all of the pests known to attack sugarcane in Louisiana. However two of the currently more important pest control problems associated with sugarcane production will be briefly discussed, with emphasis on recent findings and a look at the future in sugarcane insect research.

Sugarcane Borer

The annual cooperative survey conducted last February by the U.S.D.A. Sugarcane Insect Laboratory and the L.S.U. Agricultural Experiment Station showed that the number of sugarcane borers surviving last winter in cane trash was sufficiently heavy and widespread to cause destructive infestations during this growing season if conditions are favorable for development of the pest. By June 1 deadheart counts from several areas of the Cane Belt indicated a generally scattered infestation of first generation borers with heavy infestations in local areas. This should, under average conditions, give rise to a more uniform and injurious infestation of second generation borers throughout a major portion of the Cane Belt.

It has been emphasized in the past, and properly so, that the most logical approach to the problem of controlling the sugarcane borer is one which recognizes and places proper emphasis on the various control measures available. These have been classified as cultural practices, biological control, varietal resistance and chemical control.

Such cultural practices as shredding of cane tops, thorough clean-up during harvest, burning trash and cane pieces, chopping or shaving and wrapping of middles, early cultivation in fields heavily infested the previous year, planting borer-free cane, cutting cane at the ground level and fall-breaking of stubble fields undoubtedly aid in reducing borer infestations by destroying or reducing overwintering borer populations. Other practices such as concentrating and isolating corn plantings when possible and occasionally destroying small areas of heavily infested corn have been reported beneficial (3). Such measures should be standard practice when and where they are practical and agronomically feasible. However, these practices should not be considered insurance against injury from the sugarcane borer.

It has been estimated that a single pair of borer moths could give rise to over 200,000,000 borers in four generations (9). Fortunately this reproductive potential is never fully realized under normal conditions, thanks to such natural forces as fluctuating weather conditions and the presence of predators and parasites. Considerable attention has been given to the latter, particularly to the egg parasite, Trichogramma, which is now available commercially for release in cane fields. The release of these laboratory-reared parasites in the field suddenly increases their number there to a level higher than the original Trichogramma population had been able to attain by the time of release. Such a change in the natural balance between borer and parasite populations probably increases the efficiency of the total parasite population to some extent. Just how much saving is realized by this practice in terms of immediate crop yield is uncertain. Certainly the release of parasites is appealing from the standpoint of cost of treatment per acre, but again cannot be depended upon to control severe borer infestations.

When borer populations reach sufficiently destructive levels to warrant insecticide applications the time for cultural control measures is past, and the parasite and predator populations have not kept pace with the borer population. The latter should not be considered unusual, but is normal, since an increasingly large host population is prerequisite for the continued increase in numbers of its natural enemies.

Chemicals are commonly employed in Louisiana to control second generation and in some instances second and third generation cane borers. Forty per cent ryania dust and cryolite are recommended and commonly used at the present time. Early research with synthetic organic insecticides led to the conclusion that these materials were of no use in most of the cane growing areas of Louisiana because of their toxicity to the natural enemies of the borer (6). This conclusion was based upon the observation that although several of these compounds showed good initial control of the cane borer, the insect often increased to levels higher than those found in untreated plots during the interval between the last dust application and harvest. This suggests the possibility of extending the dusting period by increasing the number of dust applications, by increasing the length of the interval between applications, or by some practical combination of the two. Studies of this sort were conducted with ryania in 1953 and 1954 and indicated that both increasing the total number of dust applications and extending the control program beyond the usual second generation dusting may result in greater profits (5, 7).

In studies conducted during the past two years (2, 6) endrin and toxaphene have shown considerable promise. Results with 20 per cent toxaphene dust have not been as uniform as those with two per cent endrin dust, however both have shown better control of borers than 40 per cent ryania dust. This control of the borer has resulted in increased yields of cane and sugar per acre in tests at Centerville and Bunkie, Louisiana. The use of eight airplane applications of two per cent endrin dust and granules to control both second and third generation borers at Bunkie in 1956 resulted in 97 and 98 per cent reductions, respectively, in the numbers of bored joints at harvest-time. This unusual degree of control was reflected in average increases of 1,847 pounds of sugar per acre resulting from the use of endrin dust, and 2,050 pounds of sugar per acre from endrin granules. These increases gained in terms of tons of cane per acre were 8.46 tons for endrin dust and 8.54 tons for endrin granules. Considerable increases in yield were also realized from the use of 40 per cent ryania and 20 per cent toxaphene dusts, but were of the order of one-half of those resulting from the use of endrin. In a small-plot experiment conducted at Centerville, Louisiana in 1955 endrin and toxaphene dusts resulted in better borer control and larger increases in yield of cane and sugar per acre than did 40 per cent ryania dust. The use of all three insecticides to control both second and third generations of the borer resulted in yield increases greater than those obtained from only second generation control.

If endrin and toxaphene, particularly endrin, continue to give the same sort of control accompanied by increased yields this year that they have for the past two years, what could prevent their being recommended for sugarcane borer control? Possibly two things. First there is the possibility of the presence of insecticide residues in the edible products of the crop. Samples of sugarcane juice were taken last year for residue analyses. This analysis is a troublesome, expensive and time-consuming operation and all of the results are not yet available. A more extensive effort is being made this year to gather additional residue data, and it is hoped that the results from this year's analyses will be obtained more rapidly. The second possible objection to the recommendation of endrin or toxaphene for borer control lies in the effect that these chemicals might have on the natural enemies of the sugarcane borer. This is a question definitely worthy of consideration. We hope to obtain information this year regarding the effects of these materials on the Trichogramma egg parasite.

If endrin and/or toxaphene continue to give a degree of borer control accompanied by increased yields of cane and sugar in this year's experiments as they have in the past two years, and if chemical analyses show them to be safe from the standpoint of residue hazards, these materials may be recommended for use in the Bunkie area next year. Further testing would be necessary before any of these synthetic organic insecticides could be recommended for the entire Cane Belt.

This year studies are underway to compare granular with dust formulations of endrin and toxaphene, and to try to extend the length of the interval between applications from one to two weeks, thereby reducing the total amount of insecticide required to control a single generation of borers and making possible the control of two generations for the present cost of controlling only one.

At the present time checking of fields to determine when and where to dust is a troublesome and technical problem, but nevertheless a necessary one. Fortunately for the growers this service is commercially available. It seems possible that the highly technical nature of this problem may be the natural result, at least in part, of the present restriction of chemicals recommended for borer control to materials that are not sufficiently toxic to the insect. With the use of a more toxic chemical, such as endrin, it is possible that the exact time of application could become less critical. Also the degree of borer infestation presently deemed necessary to warrant chemical control measures might be lessened, but not to the extent that a substantial profit from treatment in dollars and cents could not be realized.

Several of the possibilities mentioned thus far are not yet supported by experimental data. However, they do represent some of our thinking at the present time and indicate the direction being taken in some of our research related to the sugarcane borer.

Soil Insects

For several years the L.S.U. Agricultural Experiment Station and the U.S.D.A. Sugarcane Insect Laboratory have conducted experiments designed to find chemicals for controlling soil insects and related animals which attack sugarcane. This has been a difficult problem and one which has not yet been satisfactorily solved. Soil insects spend a large portion of their lives on or beneath the soil surface so that their presence usually goes unnoticed, except in cases where infestation is so heavy that plant injury or retarded plant growth becomes readily apparent.

Numerous field experiments with soil insecticides have permitted the recommendation of chlordane as a soil treatment to be applied at the rate of two pounds of insecticide per acre on the cane seed pieces in the open furrow shortly before covering with soil (8). This treatment is presently recommended on heavy soils in the cane growing area of Louisiana where it is believed to control a miscellaneous group of small insects and related pests. It is also recommended to control wireworms in sandy soils.

In some instances decreased yields have resulted from soil treatment, and this has been somewhat more common on sandy soils where wireworms were not a problem than on heavy soils (8). An explanation for this phenomenon is not presently known, but it does indicate that further study is needed.

One of the most pressing problems relative to soil application of insecticides is that of increasing our knowledge of the insects and related pests which inhabit the various soil types on which sugarcane is grown and the injury they may inflict. Some studies have been made along these lines by the Houma and Baton Rouge stations (4, 10), and further work was initiated this spring at Baton Rouge.

The process of studying soil animal populations is a slow and laborious one, but one which has already begun to yield dividends. Previous work in Louisiana has incriminated certain centipedes, millipedes, springtails, bristletails, Symphylids and snails as being the most important small soil inhabitants which injure sugarcane by gnawing roots or pruning root hairs. Among the larger soil insects, wireworms, the sugarcane beetle and sugarcane weevil have received special mention as pests which may cause injury of importance (4, 10).

Renewed efforts this spring to learn more about the soil-insect complex present in cane fields have so far been limited to examination of soil samples in the field. These samples have consisted of one cubic foot of soil containing a stool of cane. The soil is sifted and examined by hand on the spot. Usually two men examine the soil while a third one dissects the underground portions of the plants. All insects and other small animals that are found are recorded and saved for identification or further study. As of June 1 only 238 of these samples had been examined from four cane fields. This small beginning has revealed the presence of substantial numbers of white grubs, southern corn rootworms, grape colaspis larvae, ants, millipedes and more than one species of soil-inhabiting bug with piercing-sucking mouthparts. The latter belong to a family of insects commonly referred to as "burrower bugs." The adults are black or brown in color and about one-fourth inch or slightly less in length. Nine species of this family have been reported as pests of sugarcane from several places around the world (1), but little is known of their habits or of the injury they inflict. (They have been reported to suck sap from various plants near the ground.) Thirty samples examined in a field of heavy soil at Franklin, Louisiana showed an average of five burrower bugs per sample in spite of the fact that three-fourths of these samples were taken from chlordane treated plots.

White grubs, southern corn rootworms and grape colaspis larvae have not been considered important pests of sugarcane in Louisiana, however their presence in several fields indicates that they too may bear watching closely. They are important pests of corn, peanuts, grasses, clovers, and a variety of other plants in various parts of the country.

We believe that the soil-insect complex in Louisiana cane fields deserves much more work. A good start has been made during the past several years, and we hope that in time to come additional knowledge of the pests involved together with further information on the effects of insecticides, dosages and methods of application will enable us to control this group of pests more efficiently.

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A REPORT OF FURTHER STUDIES ON THE RATOON STUNTING DISEASE OF SUGARCANE IN LOUISIANA, 1957

R. J. Steib, I. L. Forbes and S. J. P. Chilton

In order to determine if the heat treatment now recommended for the control of the ratoon stunting disease in Louisiana is the best to use, a number of treatments, both hot-air and hot-water, were used to treat diseased stalks of C.P. 44-101 and C.P. 36-105. While treating the cane, thermocouples were placed in the cane stalks to determine the exact temperature from the start to the end of the treatment. An examination of the plant cane progeny from the hot-air treated cane revealed that 17.5 per cent of the stalks were diseased when the internal temperature of the stalk was kept at 50°C (122°F) for 4 hours but when kept for 5 hours at the same temperature the disease was eliminated. When a higher temperature for a shorter period of time (52°C for 3 hours) was used, 5 per cent of the stalks were found diseased in C.P. 44-101; however, a 4 hour exposure at the same temperature was effective. The 53°C for 2 hours and 54°C for 1 hour treatments were sufficient to control the disease. The treatments which controlled the disease did not reduce the stand in the spring. The same varieties plus variety Q. 28 were treated with hot-water in order to compare the two heat treatments. Since it is known that hot-water will cause a serious reduction in germination in the spring in Louisiana, only two treatments, 50°C for 2 hours and 50°C for 2 1/2 hours were tried. Examination of the cane showed that the disease was not eliminated by the 2 hour treatment in the case of C.P. 44-101 and Q. 28. The 2 1/2 hour treatment was effective in eliminating the disease from C. P. 44-101 and C.P. 36-105, but not from Q. 28. These two treatments did not affect germination in the spring.

A number of yield tests were planted to determine losses caused by the ratoon stunting disease. C.P. 44-101 free of the disease gave an average increase of 9.0 tons per acre in the plant cane and 17.0 tons per acre in the first stubble. For C.P. 36-105 the increase was 9.4 tons in the plant cane and 15.9 tons in the first stubble. The average reduction in yield between plant cane and first stubble in the diseased plots of C.P. 44-101 was 4.4 tons and for the same plots of C.P. 36-105, there was a reduction of 6.9 tons per acre. A similar comparison made of the disease-free plots showed that the first stubble of C.P. 44-101 gave an increase of 3.6 tons per acre over the plant cane; while for C.P. 36-105, there was only 0.4 of a ton difference between the plant cane and first stubble yield. There were no significant differences in sucrose between the diseased and healthy cane in both plant cane and first stubble.

A comparison of yields between disease-free and inoculated cane using varieties C.P. 29-116, C.P. 29-320, C.P. 33-224, C.P. 47-193, C.P. 48-103 and N.Co. 310 showed that the disease-free plant cane plots outyielded the inoculated plots except for C.P. 29-116, C.P. 47-193 and N.Co. 310. In the first stubble crop a significant increase in yield was noted for all varieties, including C.P. 29-116, C.P. 47-193, and N.Co. 310. The average sucrose for the inoculated cane was slightly higher than the healthy for both crops.

In another yield test, seed cane known to be either healthy or diseased by examination of each seed piece before planting was used to determine precise losses caused by the ratoon stunting disease. Plant cane weights taken in 1956 showed that highly significant increases in yield may be expected from disease-free cane in a year of low rainfall. Increases in yield per acre were as follows: C.P. 28-19, 10.5 tons; C.P. 29-320, 8.9 tons; C.P. 34-120, 7.7 tons; C.P. 36-105, 8.5 tons; C.P. 44-101, 11.2 tons and Co. 290, 4.1 tons. There were no differences in sucrose.

Spread of the disease from plant cane to first stubble by the sugarcane knife was found to be very rapid. Plots found 16 per cent infected in the plant cane became 47 per cent infected in the stubble. Those 50 per cent infected were 80 to 90 per cent infected in the stubble.

Cost of heat-treating a ton of seed cane in the electric oven is $13.00. This includes labor, electricity and depreciation of the oven. Planting treated cane directly from the treater for commercial production is obviously too costly. A plan to use the progeny after either one or two years, depending on acres to be planted, would reduce this cost to $2.17 per ton after the first year and to 47¢ per ton after the second year.

SUGARCANE PLANTER PROGRESS REPORT FOR 1956

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Agricultural Engineering Research Branch, Agricultural Research
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The 1956 sugarcane planter research program, conducted in cooperation with the American Sugar Cane League, was concentrated on improving the two-row planter built in 1955. The service requirements for the planter were as follows:

1. The planter shall be tractor-mounted to facilitate planting the ends of the rows and turning.
2. The planter seed hopper shall have a capacity of 2 to 3 tons.
3. Rows are to be partially opened prior to planting to reduce planter power requirements.
4. The planter shall be capable of completing the furrow to the desired depth and width.
5. The planter shall be capable of handling field length seed canes with adhering trash with provision for cutting the canes in half.
6. Seed canes are to be transferred from the transport cart to the planter with a winch truck in 1- to 1-1/2 ton sling loads.
7. The planter shall be of two-row design for planting one row on each side of the tractor.
8. The row spacing shall be standardized at 5 feet, 10 inches.
9. The rate of planting shall be adjustable to secure a uniform distribution of seed.
10. Power steering shall be used to assist the operator.

Prior to the planting operation the furrow is partially opened with a tractor equipped with middlebreakers and gauge wheels mounted on the rear tool bar as illustrated in Figure 1. With this tool arrangement it is possible to standardize the row spacing essential for the operation of the planter.

The construction of the planting machine is illustrated in Figure 2. The planter is designed to straddle one row and plant the two adjacent rows. Each row unit consists of a guage tire (that rolls in the partially opened planter furrow), a middle breaker type furrow opened (with the moldboard clipped to reduce soil movement), and a planting trough consisting of two sides for holding the soil out of the planting furrow during the planting operation. The row units are raised and lowered independently at the front, thereby making it possible to plant a single row. In the raised position the unit has a ground clearance of approximately 16 inches. During the planting operation the weight of the unit is carried on the gauge tire, thus allowing the unit to float vertically independently of the remainder of the planting machine.

In the 1955 design each of the two seed hoppers was located between the feed chute and the tractor engine. It was found that this arrangement did not provide sufficient seed capacity and was difficult to load properly due to the wide variation in bundle sizes. In addition, since both hoppers were seldom exhausted at the same time, canes had to be transferred by hand between hoppers to completely empty both at the same time. The amount of trash and soil included with the cane made it necessary to completely empty the hoppers after each load to avoid an accumulation of this material on the hopper floor and prevent an excessive amount being mixed with the next load of seed cane.

To overcome some of the objections to the two-hopper arrangement the engine, propelling transmission, and wheels of the tractor were reversed, thus permitting the two seed hoppers to be combined into one large hopper. The revision provided a 10' x 10' seed hopper which was adequate for 2 to 3 tons and could be loaded from either side with the winch truck. The front wheels and axle of the tractor were removed and mounted on the front of the planter. The engine of the tractor unit was supported by extending the main frame of the planter. The chain drives of the wheel drop housing were replaced with spur gears to reverse travel direction. In low-low gear the ground speed was 1.38 mph at 1213 rpm engine speed. The method of transferring the canes from the transport carts to the planting machine is illustrated in Figures 3 and 4.

The length of the seed feed mechanism was increased from 8 feet 3 inches to 10 feet 3 inches to permit two stalks of seed to be dropped simultaneously. The feeding mechanism used in 1956 consisted of a feed chute, feed roll, and saw. The seed canes were dropped lengthwise by hand, two at a time, into the feed chute. The feed roll was equipped with one row of fingers for discharging the seed cane into the planting trough. The feed roll device was changed from a constant speed drive to an interrupted drive to assist in the positive discharge of the canes and to reduce wrapping of trash on the feed cylinder. Stripping bars were provided next to each feed finger to assist in the dropping and to reduce carryover of trash. The rate of seed planting was varied by changing the frequency of discharge in relation to the forward speed. The desired rate of planting, or lines of cane per row foot, depends upon the length of the seed cane and the frequency of discharge relative to the ground speed. The desired rate was obtained by changing feed sprockets. This arrangement permits a normal range of from 1 to 3 lines. When the seed canes were longer than the calibrated length the rate of planting was increased in direct proportion.

The field testing of the experimental two-row sugarcane planter was conducted in cooperation with Gulf States Land and Industries, Inc. (formerly Godchaux Sugars, Inc.), Raceland, La., from September 10 through 22 and on October 13. During the first test period all the seed cane was hot water treated for ratoon stunting disease. The treated seed was loaded directly on the planter at the treating plant to prevent possible contamination with untreated seed. In these tests 36 percent of the total time was spent planting, and 64 percent of the time was devoted to loading, moving, and waiting for seed. The average planting time for 24 consecutive loads was 33 minutes per load, averaging 2-1/2 to 3 tons of seed cane. Most of the cane was straight and was loaded on the planter in bundles of 1000 to 1200 pounds. The results of these plantings are summarized in the following table:

Date	Block	Cut	Acres	Variety	Tons per acre
Sept.					
10, 11	C125	C, D, 17 rows of E	8.00	C.P.43-47	3.25
12	C168	6 rows of D, E, 6 rows of F	3.41	C.P.36/105	3.07
13	C88	B, C, D	2.99	C.P.48/103	4.13
14	C92	12 rows of G	1.82	C.P.48/103	4.13
15	C30	A, B, 15 rows of C	4.10	C.P.36/105	3.07
17, 18, 19	C177	14 rows of K, 10-1/2 rows of G, H, I, J	6.87	C.P.36/13	2.75
19	C177	10-1/2 rows of G	.88	C.P.44/155	3.41
20	C120	6 rows of C, 12 rows of D, E	3.90	C.P.44/155	3.41
22	C177	F	1.06	C.P.47/193	3.37
Oct.					
13*	C28	E, F	4.05	C.P.36/105	3.07
			37.08		

*Untreated seed, field loaded, badly bent and broken by the hurricane on September 23, 1956.

All the field testing was done without covering tools so that gaps could be filled and the canes positioned at the quarter drains and at the ends of the rows. During most of the tests one man followed the planter to fill gaps and make the quarter drain breaks. Occasionally the feed cylinder was choked by canes or trash, however the frequency of choking was not as great during the 1956 tests as in 1955. It has been observed that the frequency of choking is greater with crooked canes. On the October 13 test the hurricane-damaged seed cane was difficult to load and caused frequent chokes. It was found that two feeders per row improved the uniformity of planting and increased the travel speed of the planter.

Observations and conclusions on the operation of the two-row sugarcane planter are as follows:

1. The seed hopper had sufficient capacity to take care of the wide variation in bundle sizes and permitted two feeders to be used for each row.
2. Hydraulic steering and stronger brakes improved the handling of the planter especially when loaded.
3. The difficulty of separating the individual seed pieces because of trash is the main capacity limiting factor.
4. Hurricane-crooked seed cane was found difficult to feed without choking the feed cylinders.
5. The two-row planting machine is easy to handle and has adequate power for low ground speeds.
6. On October 13 a capacity of 5.85 acres per 9 hours was obtained when planting hurricane-crooked seed cane.
7. Pre-hurricane planting time for 24 consecutive loads of 2-1/2 to 3 tons of seed cane averaged 33 minutes per load.

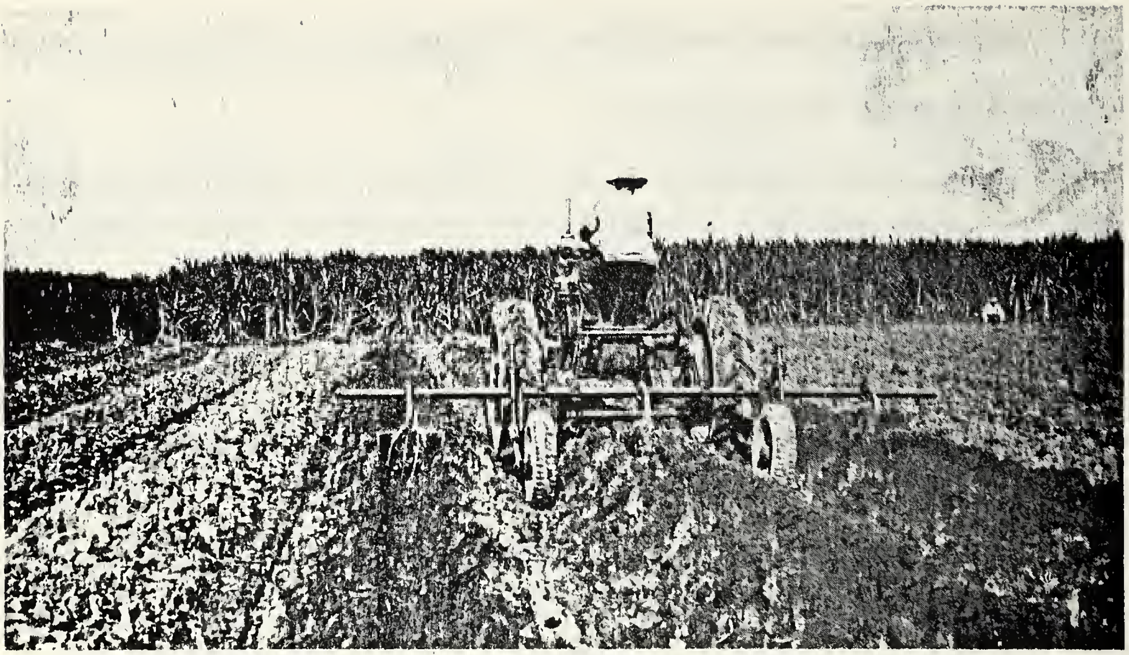

Figure 1. Rear view of cane tractor equipped with three furrow openers and gauge wheels.

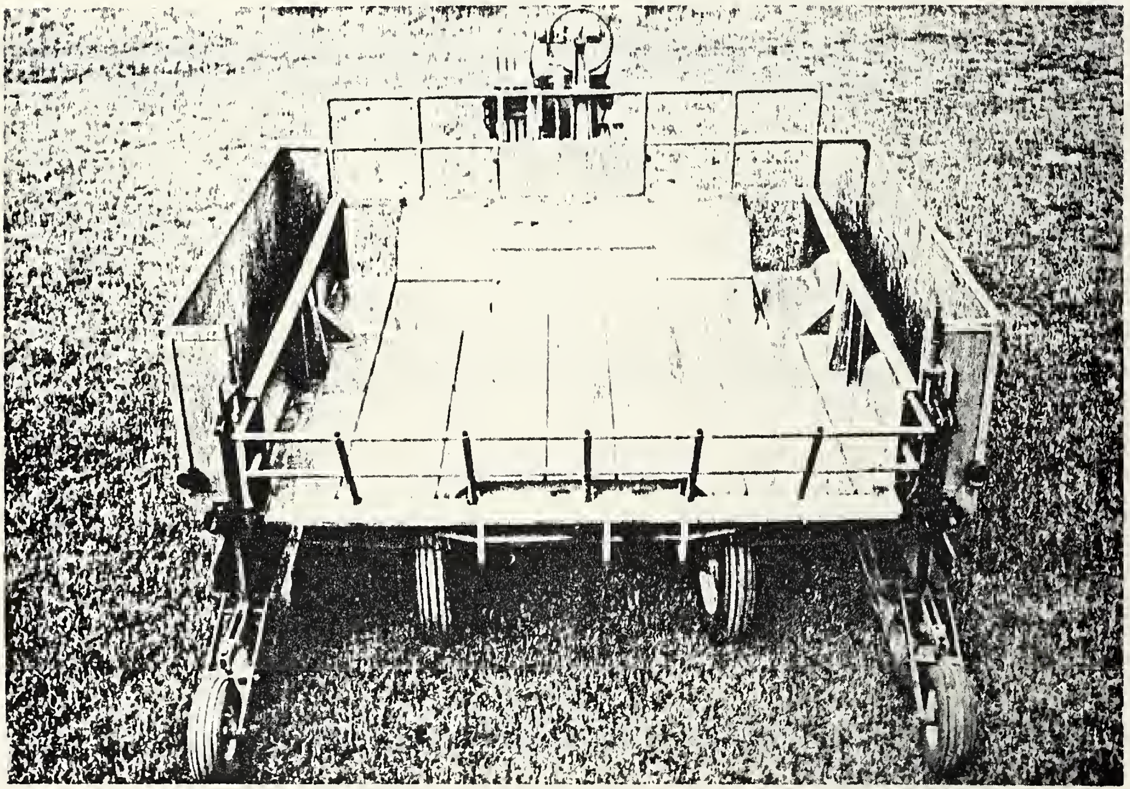

Figure 2. Front aerial view of two-row experimental sugarcane planter showing general arrangement of seed hopper, feed chute, and opener gauge tire.

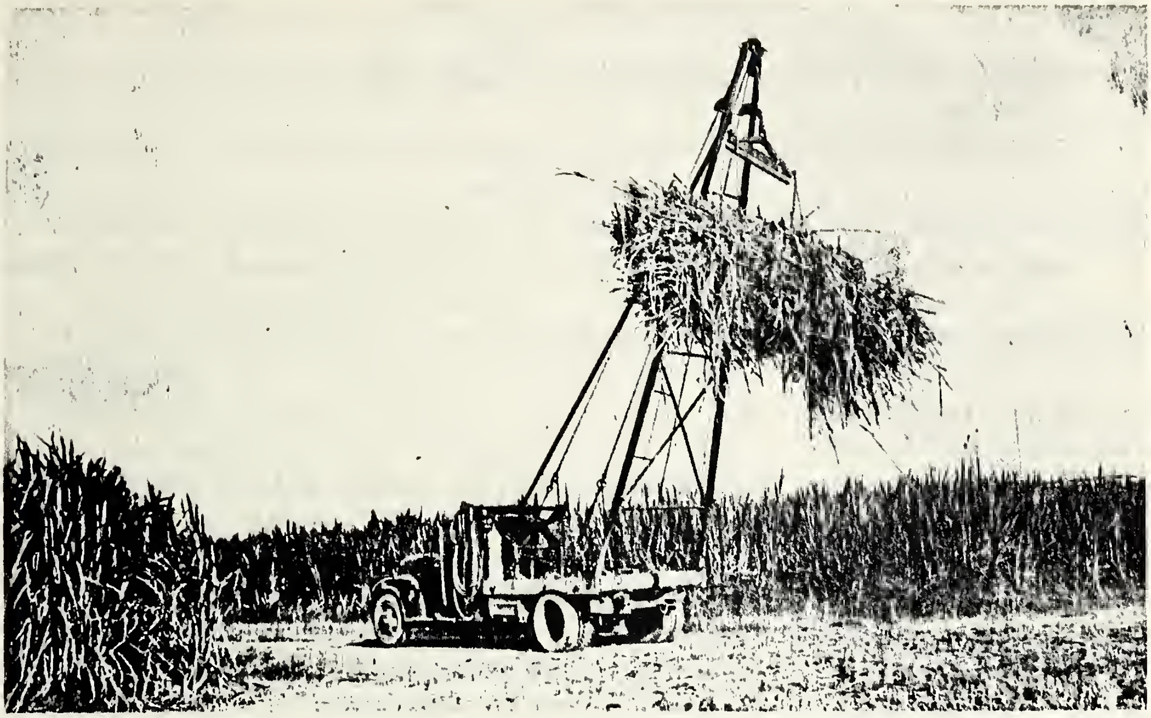

Figure 3. Winch truck equipped with long boom for transferring seed cane from the transport carts to the cane planting machine.

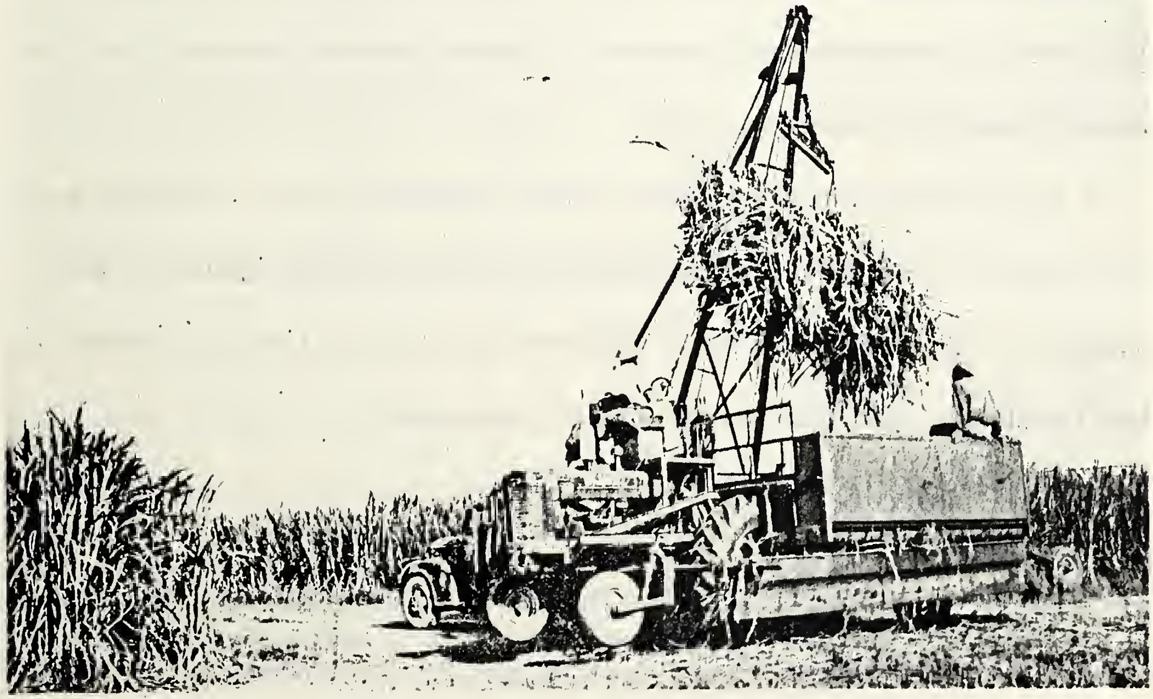

Figure 4. Transferring seed cane from the winch truck to the experimental planter.

WHAT ABOUT VALVES

William A. Boles

Introduction

Valves are actually a very common piece of equipment and are used quite extensively in your Mills and Refineries. We wonder though, if many of you realize what your valves cost you each season. The words Selection, Installation, Maintenance, and Operation will be mentioned several times during this discussion, but they are the four key words to arrive at the most economical service you may receive, whether it be Valves, Pumps, Motors, etc. Any piece of equipment must be properly selected, installed, maintained and operated to give the ultimate service for the minimum expenditure. The high cost of maintenance is going higher and higher each season, and we believe that with the proper selection, installation and operation of these valves you could see a decided drop in maintenance cost.

It is impossible in this short time to go into great detail, but we hope to give you a better understanding of valves in the following discussion. We want all of you to feel perfectly free to interrupt at any time to ask any question that comes to your mind.

What is a Valve?

To get on a solid foundation let's look at the definition of a Valve. A Valve is a mechanical device usually used in connection with a pressure containing vessel to stop completely or regulate the flow of a fluid. This tells the whole story. A Valve is a mechanical device and is subjected to all the ills of a mechanical device. It must be properly selected, installed, maintained, and operated to function properly. The word "Connection" suggests flanged, screwed, butt welding, socket welding and all other types of connections. The words "Stop Completely" or "Regulate the Flow" suggests the different usages of a Valve.

Basically, there are three types of Valves. These three types stop completely or regulate the flow of the fluid. They are the Globe, Gate, and Check. All the hundreds of types of Valves you see in Valve Manufacturer's Catalogs are derived from these three types of Valves.

Selection

Now, we must select the proper valve for the various services.

First, we will take the Standard Bronze Gate Valve. The principal parts of a Gate Valve are the Body, Seats, Disc, Stem, and Bonnet. The threads on the Stem and in the Bonnet is the mechanical device which is used in opening and closing the Valve. Let us look at the valve in the closed position. The pressure is pushing against the Disc on the up-stream side, but no fluid passes through the Valve. Now let's open the Valve wide open. In this position the Disc goes up into the Bonnet out of the flow area and leaves an unobstructed opening through the Seats. Now, we will close the Valve halfway. In this position the Disc is protruding into the flow area and you acquire wear on the bottom up-stream side of the Disc and the bottom of the down-stream side of the

Seat. Because of this uneven wear you are unable to get a positive shut-off when you close the Valve down. From this, it is determined that a Gate Valve is to be used on a service where the Valve is to be completely opened or completely closed. Not to regulate with.

Gate Valves are made in sizes from one quarter inch to thirty-six inches, and they are made out of bronze, iron and steel. They are also made with all the connections as mentioned in the first paragraph.

The second type Valve is a Globe Valve. The principle parts of a Globe Valve are approximately the same as a Gate (as we can see in the diagram) but the construction is quite different. The seat in the Globe Valve is parallel with the direction of flow instead of somewhat perpendicular to the direction of the flow as they were in a Gate Valve.

The Disc of a Globe Valve comes directly down on to the seat opening. When the Valve is in a closed position the pressure is pushing up or down against the Disc according to which way you have the Valve installed. When the Valve is wide open the Disc goes up against the Bonnet, but you don't have a full opening because of the webb in the Body which contains the Seat. Now, let's close the Valve halfway. We have here, unlike the Gate Valve, theoretically, even wear all the way around the Disc Face and Seat Rings. Then, when you close the Valve you get, theoretically, a positive shut-off. In the Standard Globe and Gate Valve you have Bronze Seats and Discs. As the temperature, pressure, corrosion and erosion conditions increase we must put special Allpy Seats and Disc in the Valve to withstand these conditions. From this, we have determined that a Globe Valve is to be used for regulating the flow of a fluid or, as is more commonly used, for throttling.

The Globe and Needle Valves, (Needle Valves are of the same basic construction as a Globe Valve, therefore, are in the Globe Valve family) are made in size from one eighth inch to fourteen inches or larger. Like the Gate Valves they are made of Bronze, Iron, and Steel and with the various connections we mentioned before.

We have one other type of Valve and that is the Check Valve. A Check Valve is a sort of a policeman in your pipe lines. It will permit flow in one direction, but will not permit it in another. In other words, a check valve checks flow from reversing in a line where you have had a pump failure or a shut down.

There are, basically, two types of Check Valves, the Swing Check, and the Lift Check. The Swing Check, because of its construction, is in the Gate Valve family; and the Lift Check, because of its construction, is in the Globe Valve family. Like the Gate and the Globe Valve the Check Valve is made in various sizes, pressure, and temperature ranges, different types of metal and with the same connections as mentioned before.

We have now covered the three basic types of Valves; Gate, Globe and Check. From the basic principles contained herein we would branch off into various other types of Valves, but they would all be basically built around the Globe, Gate, and Check and would stop completely or regulate the flow of the fluid.

Though time doesn't allow us to discuss the various types of

Valves we would like to discuss two Valves that are widely used in your industry and, to Valve Manufacturers, are sometimes abused. These are the Pop Safety Valve, and the Relief Valve. The Valves are similar in construction, but there is a decided difference in their application. The Pop Safety Valve is to be used on a gaseous service. Gas, Steam, and Air are compressible and the Pop Safety Valve is so constructed to efficiently handle this type of service.

The Relief Valve is to be used on a liquid. Liquids are not compressible and, therefore, has different characteristics than does a gaseous fluid. The Relief Valve, therefore, is constructed to handle efficiently a non-compressible liquid.

I'm sure most of you are somewhat familiar with these two Valves and may understand the principles behind their construction. When these principles are once learned the Valve becomes as simple as any other type of Valve. If you do not have an operating knowledge of these Valves, they can become a headache, very costly to your operation and in some cases, very dangerous. It is suggested that if you do not fully understand the installation, operation, and maintenance of these Valves, you get in touch with your nearest Valve Supplier and acquire literature explaining the proper usage of the Safety and Relief Valves.

Selection

In the above we have discussed mechanical application of Valves. To you in the Sugar Industry there is another subject which is of great importance and that is Corrosion and Erosion; you have both in your Mills. From your commercial acids and your sugar acids you have Corrosion; from sand, dirt and grit, as well as your sugar grain, you have erosion.

In the Valve Industry we have attempted to solve some of these problems for you. As you know all metals contain a certain amount of erosive and corrosive resistance. For example various types of acids will attack Bronze, but will not attack Iron. At the same time, water will rust iron, but it will not rust bronze. Nickle in many cases is very resistant to certain types of acid and by adding a certain percent of nickle to your cast iron you get a valve that is generally very resistant to certain types of acid. Manufacturers make valves from 3% Nickle Iron to as much as 20% Nickle Iron. These Valves are very resistant to your sugar acids. This is strictly the body material. In these valves we can put Monel Trim or Stainless Steel. Both of these metals are resistant to your Sugar Acids and are also more resistant to your erosion than Iron or Bronze. Of course, these valves are more expensive than all iron valves or IBBM Valves. We feel that in the long run it will save you money.

Problems such as this one we have discussed is of great interest to Valve Manufacturers. Any time at your request we will be glad to come into your Mill and work out some of these problems with you.

Installation

Now, that we have determined what type of Valve is to be used on which service, let's consider for a minute the installation of Valves. This subject is quite important because if the Valve is not properly installed it won't give the desired service. For example: If in threading your pipe ends you cut the pipe threads too long the pipe ends may be forced into the Seats of A Gate Valve; or into the Webb of a Globe, distorting the Seats and causing a leak when the Valve is to be shut-off. If possible, all Valves should be installed in a line in the upright position. That is, with the Stem pointing straight up. It is realized that many of your installations will not permit you to do this, and in this case, it is permissible to tilt your Valve to one side or another, but never exceeding ninety degrees from the straight up and down position. Again there are installations where the Valve must be installed in the inverted position. This will, in many cases, shorten the life of the Valve because most of your sediment will fall into the Bonnet and cause excessive wear on your Bonnet and Stem Threads. If it is at all possible, when the Valve is installed in this position, take the Bonnet off and clean it periodically. Another thing to watch for is when you put a new Valve on a line make sure that all the dust, dirt, and grime is cleaned out of the Body and especially, around the seating surfaces.

By looking at a Gate Valve you can tell that it makes no difference how you install it. Because of its construction it will work either way. With the Globe and Check it's a different story. The Check Valve must be installed so that the pressure alone will push the Disc off of the seat. Most all of your Check Valves, have an arrow on the body showing the direction of flow so you can't go wrong. In case there isn't an arrow you can go according to the printing on the side of the Valve.

The direction of flow is generally in the same direction that your printing reads from left to right.

The question of how to install a Globe Valve has caused many heated discussions as to whether you install a Globe Valve with the pressure on top of the Disc or on the bottom of the Disc. In looking through your ASME Boiler Code you will find but one instance where they require you to install a Globe Valve a certain way, and that is on the boiler feed line. In this case, a Globe Valve must be installed with the pressure on the bottom of the disc. The reason for this is that if by some freak accident the Disc should fall off of the Stem Head and fall into the Seat Opening the pressure would push the Disc away and continue the flow of water into the boiler. Whereas, if the Valve were installed with the pressure on top of the Disc and the same thing were to happen, the pressure would shut the Valve off. Other than this required instance, we, as Valve Manufacturers, feel that it makes no difference how you install a Globe Valve. We would like to give you some of our thoughts along this line, but please understand that they are merely suggestions.

We have found that you could get better service out of a Globe Valve installed on open end line by installing the Valve with the pressure on top of the Disc. For example, we'll take an open end Steam Line in your plant, where you have a Globe Valve installed on an open end line, you put a Nipple and a piece of Hose on the end of your Valve. This is our thinking on this installation. When an open end steam line Valve is shut down, after use, the valve naturally cools and the stem shrinks. There is always play between the stem head and the Disc. This coupled with the fact that the pressure is pushing the disc down when the valve is installed with pressure on the top of the disc the pressure would keep the valve tight by check valve action.

Maintenance

From a maintenance standpoint most all Valves are repairable. In the Standard Pressure and small Bronze and Iron Valves there is very little you can do to repair them. If the Bronze Seat and Disc aren't pitted too bad you can usually re-surface them with emery cloth or grinding compound. As you get into higher pressures, temperatures, corrosive and erosive conditions, the valves have renewable Seats and Discs so that when they are worn out you can replace them with new ones. Even in the case of Valves with renewable Seats and Disc they can be taken out of the line at the first sign of a leak and the seating surfaces reworked and put back into service almost as a new Valve. Another thing to watch for is leaks around the Packing Glands. When a leak shows around the Packing Gland it may only need the Packing Nut tightened or the Valve may need repacking. It is always a good thing to check the tightness of the Packing Nut when the Valve is first put in service. Leaks around the Packing Gland should be looked after immediately. Tightening a Packing Nut, or repacking the Valve at the first sign of a leak may save you from replacing a Stem or complete Valve later.

Operation

Last, but not least, comes the subject of operation. In most plants there are several Valves that are opened and closed quite frequently. It it realized that it is sometimes necessary to use a cheater on a large Gate Valve to open and close the Valve. We'll also grant you that it is necessary to do this with small Valves occasionally. If it stopped at this it would be fine, but sometimes we forget and use the cheater on Valves, regardless of size, service, or what have you. Valve Manufacturers build their handwheel so as to give you enough leverage to open and close the Valve with your hand, under normal conditions. If a cheater is needed there may be something mechanically wrong and the Valve should be taken off the line and inspected.

Most of the information contained in this paper is theory and it is understood by most of us that theory alone doesn't get the job done. We do feel though that this theory along with the practical knowledge of Valves, which is acquired only through working with Valves, can be of help to you in your Valve problems. It is sincerely hoped that we have given you some information which will be of some help to you.

WEIGHING OF SUGAR ON CONTINUOUS BELT CONVEYER TYPE SCALES

Patrick E. Cancienne
Lula Factory, Inc.

We started storing raw sugar in bulk during the 1954 crop.

For those not acquainted with our sugar conveyor system at Lula, I will describe the system.

All raw sugar coming from the centrifugals is dumped on an endless belt conveyor that passes over the belt scale. After passing over the belt scale it can either be dumped into a storage bin for loading into trucks or for shipping or dumped into the warehouse for storage.

Each day we would ship some sugar out by truck. This gave us an opportunity to check the scale error each day. Assuming that this error was 5% above the weight that we loaded into the trucks, we would then apply this correction to the amount of sugar that went into storage for that day.

Another method that we used to keep the scale reading as nearly correctly as possible was to run the scale empty for a period of half an hour. During that period the scale checker would notice the reading on the weight-meter. If the meter would increase with the belt empty, he would adjust the counter-weights until the meter reading would remain constant.

Our third check was to see that the brush was doing a good job of cleaning the belt at all times.

By keeping a close daily check on the scale and everything connected with the weighing of sugar we kept the scale error nearly steady, as it didn't vary more than 2% from one day to another.

Following is the actual amount of sugar stored each year and percent error in weights between the actual amount we had stored and the weights we had from using the continuous scale during the grinding season:

Year	Storage	Error
1954	8,789,840#	0.35%
1955	12,862,324#	0.23%
1956	13,081,600#	0.57%

In closing I would like to emphasize, that if we couldn't check our scale daily to find the percent error and apply this error to the sugar that went into storage each day, our total error on the weight of sugar in storage would probably be far off and it would be a guess as to how much sugar we had in storage at the end of the grinding season.

BOILER HOUSE PRACTICES
IN
LOUISIANA SUGAR FACTORIES

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Introduction

In standard practice the use of personal pronouns is to be avoided, however, whenever the remarks of the author are derived from personal observations and the statements made are subject to criticism and differences of opinion not being established by irrefutable facts then it is the opinion of the author that he should hold himself personally responsible for all remarks contained in the paper that are critical in nature. We respectfully apologize for this deviation from standard practice of presentation of this paper and assure that there is no intention for personal aggrandizement when the personal pronoun is used in this presentation. We invite criticism of our remarks and refutation of any statements made in this paper that justify same and without personal offense being felt whatsoever.

The Boiler Hours

In our thirty-five years of experience in Louisiana sugar factories we believe that the "Boiler House" of a Louisiana sugar factory is the "Stepchild" of the Factory.

It is true that the word "Boiler House" is a misnomer as in engineering practices of this date the so-called "Boiler House" is really the "STEAM GENERATING PLANT." We believe anyone interested in the grinding of sugarcane and manufacture of sugar realizes that factually the Steam Generating Plant is the heart of the factory, but we also believe that likewise with respect to the human body most of us neglect the most important organ of the body personally by overwork, overexertion, or the various other factors that influence or deteriorate this instrument.

In a Louisiana sugar factory there is another item that does receive a great deal of consideration but is no more important and that is the MILL TRAIN or MILL TANDEM, insofar as in Louisiana we are continually fighting against possible freezes and the main idea is to grind cane at the maximum rate. This is given major importance in consideration of management of Louisiana sugar factories and rightfully so.

On the other hand, it is our opinion that the STEAM GENERATING PLANT is equally of importance because failure in the Steam Generating Department can exactly cut off the effectiveness up to 100% of the mill tandem.

We therefore say that the Steam Generating Plant is actually the heart of a sugar factory in Louisiana and that the mill tandem is the "hands" of a sugar factory that determines the amount of work that the factory (body) is capable of doing.

In a like analogy we believe an entire sugar factory's operations may be more or less compared to a human body and this applies not only to the sugar industry but to practically every industry. Food is required. Assimilation of the food without deterioration to the body is essential.

With this prelude intended only to throw the spotlight on the particular part of the sugar factory with which this paper deals we proceed as follows:

> We pause to remark that certainly there are exceptions to the examples brought out in this paper and we apologize to any factory that is operating their steam generating plant in a modern manner. Our critical remarks certainly cannot be directed against such factories.
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> We stated that the steam generating plant is the "stepchild" of the sugar factory because in our experience we find that little executive attention is paid to the steam generating plant. We regret to state that in our experience all executive decisions that we have encountered in the steam generating plant have been made of NECESSITY rather than by prethought and executive thinking. We are guilty of this practice ourselves.
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> In other words, whenever the boiler house is thought of it is only when it is necessary to replace a boiler that has served ten years longer than it should have served, and has been condemned by the insurance company. The other reasons for expenditures in the boiler house have been based on the necessity of generating more steam than the existing equipment can generate, which is occasioned by increasing grinding capacities.
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> The normal procedure in such cases as we have experienced has been to determine not exactly the best way to do the job but "HOW CHEAP CAN WE DO WHAT WE HAVE TO DO?".
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> In our opinion this is truly false economy and we plead guilty to having practiced same due to necessity and due to the fact that the sugar industry has been penalized as we all well know by low profits and an unsecure position financially. We have even advised such practices but basically we go on record as stating that it is truly a false economy and is based on "fear" rather than common sense.
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> It is our contention that the boiler plant of a sugar factory should be given as pre-eminent a place in the planning and executive thinking of a sugar industry as is the mill tandem, pan floor, or any other portion of the factory.
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> It is our opinion that the labor assigned to the boiler plant or steam generating plant generally is the most inefficient labor anywhere in the sugar factory. This is a normal occurrence in that the most intelligent labor is used where more "brain power"

is required, and it is a standard practice to accept that all of the boiler work with the exception of the so-called "water tender" can be as dumb as all outdoors in a Louisiana sugar factory. (We call attention to the introduction of this paper wherein we stated the opinions expressed are those of the author and not necessarily shared by the industry).

Before passing to the next stage of this paper we propound questions to every sugar manufacturer that receives a copy of this paper and his answer to the questions would establish whether there is any value to the author's opinion or not. We propound this now as a series of a few questions and there is no use reading past question #1 unless the answer to same is affirmative.

QUESTION #1:-

Are you satisfied with or contemplating expanding your boiler plant this year or in the near future?

QUESTION #2:-

Is this expansion or replacement one of expendiency and absolute necessity or is it a planned economy?

QUESTION #3:-

Is your thinking along the lines of "how cheap" can we do this job or how "good" can we do this job?

QUESTION #4:-

Are you planning on installing used equipment which you can buy cheaply and if you are using used equipment have you had it really evaluated by a competent engineer?

QUESTION #5:-

If you are buying new boilers or steam generators are you really evaluating the new equipment according to modern practices and adaptability to the conditions pertinent to your factory, or are you simply buying so many rated boiler horsepower or so many pounds of steam per hour at a minimum price?

We are not going to be brash enough to put an I.Q. (intelligence quotient) on the answers to these questions because they are obvious.

We do consider, however, that the seed for thought implanted in these few questions which could be extended into a real questionnaire should be taken into consideration by all sugar factory owners and operators.

As a matter of fact, we believe that some competent engineer not interested in sale of steam generating equipment should prepare such a questionnaire for the sugar industry together with the procedures that should be followed after the questionnaire has been answered.

This is more or less a standard practice in a doctor's office whenever the greatest piece of assembled machinery comes in for examination and study, and it should be applied equally as well to an inanimate object such as is a sugar factory.

We pride ourselves in trying to "diagnose" on the information we accrue whenever we are called into any job by propounding of such questions unless the knowledge is already available to us.

General

The steam plants in the various sugar factories in Louisiana can be classed in two classes, namely - the fortunate and the unfortunate.

The fortunate are those who have been able to dispose of their bagasse and operate their steam plant on natural gas or fuel oil only. The real fortunate ones being those who operate on natural gas, the most natural fuel available to the industry.

The unfortunate are those who have to burn all of their bagasse.

There is a hybrid interposed between the "fortunate" and the "unfortunate" which we should call probably the "half fortunate" who dispose of part of their bagasse through one means or another and then have to burn part of their bagasse. We might say that they are more fortunate than the "unfortunate" and less fortunate than the "fortunate." You can put yourself into whichever bracket you fall into.

General Discussion of Boiler Operation

In this discussion we shall speak essentially of the sugar factories burning bagasse in its entirety and as produced at the factory.

It has been proven that due to the low cost of auxiliary fuel available in Louisiana that it is economically unwise to store bagasse produced in excess of steam producing requirements. Therefore all bagasse must be consumed in furnaces either in the boiler house or outside of the factory as produced.

This is a unique situation in Louisiana, as the fuel value of bagasse in most tropical countries is of sufficient value and labor sufficiently low in cost to justify storage of excess bagasse for use even in the idle season.

As a matter of fact, bagasse as a source of fuel energy has been considered so cheaply that not one single installation has been made in Louisiana or for that matter in any other region of the world that has maintained in operation that would increase the fuel value of bagasse by more than 50% and in utilizing of waste heat to accomplish this purpose.

In a well balanced raw sugar factory bagasse normally produces all of the fuel required but in many factories this is not the case due to unbalanced equipment, such as lack of preevaporators, lack of vapor heating, lack of multi-stage evaporators of four stages or more, and various other factors.

As a matter of fact in many Louisiana sugar factories the unbalance (due to economic reasons) is so bad that the auxiliary fuel consumed by a raw sugar factory amounts to a sizeable figure annually. The economic question is whether by increasing the fuel value of bagasse by using rotary dryers or other dryers wherein the stack gases would be used for dehydration, increasing the fuel value of bagasse, would be more economical than expending more money to improve the steam efficiency of a factory would be most advantageous.

Certainly we cannot answer such a question positively but it is worthy of consideration anywhere. Then there is always the thought "maybe next year we can sell our bagasse."

All of these economic factors are more or less neglected in the operation of a seasonable project such as is a sugar factory in most countries throughout the world, particularly where the bagasse furnishes all of the fuel requirements and where labor is on a daily rate equal to an hourly rate in Louisiana.

We believe most sugar factories are now more aware of labor costs than they were two years ago. We further believe that an investigation will disclose that in all factories where bagasse is being burned that the labor in the boiler plant or steam generating plant is a major cost item in the labor of the factory.

There are many ways to reduce the amount of labor required in steam plant to operate a factory but all of these require (as far as we know) capital expenditures.

There are several factories (probably three) that now use pneumatic ash disposal systems and this materially reduces the amount of cleaning labor required in the boiler house. In several instances where we have recommended such a labor saving device at a cost of approximately $3,000.00 we have been advised that the "Budget" would not permit the expenditures, yet, on the other hand, if only one man is cut out of service this represents a savings of not less than $24.00 per day.

In order to add a bit of humor to this paper we wish to advise that on a business proposition we would be pleased to install such a system in any sugar factory in Louisiana on a contract by the company to pay us for the labor savings for a period of ten years and at the end of ten years we would be happy to give them this labor savings equipment free of cost.

If we had a half a dozen such accepted propositions our income would provide for our needs without a worry in the world, because it is a simple matter to borrow money on a sure thing!

There are very many types of furnaces employed for burning bagasse and Louisiana has at least twenty versions of design in this respect. Practically every engineer who has been operating a sugar plant for ten or more years has conceived ideas of improving bagasse burning equipment. We fall in that bracket.

Most of the basic principles of burning bagasse have been published in the trade magazines and in books but several have not for various reasons.

There have been many papers presented on bagasse furnaces alone but in deciding upon the furnaces to be employed in a sugar factory there are several things that should be taken into consideration which we shall briefly outline without comment on the values of one over the other with respect to existing designs.

Essentially bagasse burning furnaces may be limited to horseshoe furnaces and spreader stokers as well as common grate burners.

There are so many variations of each we cannot discuss them individually.

The advantages of one may be disadvantages in another and the disadvantages of the other may be the advantages in the one. The factories therefore should consider the design of the bagasse furnace equipment offered for their furnaces on the basis of:

1 - The annual upkeep and maintenance costs.

2 - The amount of labor required for cleaning out of the furnaces if the furnaces are mounted in the front of the boiler setting proper.

3 - The available space for auxiliary fuel combustion when bagasse supply is interrupted.

4 - The heat release per unit volume of combustion space both for burning of bagasse and for burning of auxiliary fuel.

5 - Loss of steam generating capacity during cleanout period.

In burning of bagasse alone we believe that the furnace volume where combustion takes place and prior to entrance of combustion gases into the tube banks of a boiler should be kept to 20,000 Btu per cubic foot of furnace volume per house.

We further believe that auxiliary fuel burned either with bagasse or alone should be provided with sufficient furnace volume to not have a heat release of more than 25,000 Btu per cubic foot per hour.

The above figures are based on refractory wall furnaces without water wall tubes.

When water wall tubes are added to a boiler these figures can be safely increased but it must be borne in mind that more knowledge must be employed in the boiler house than is generally practiced as of this date.

In most instances in Louisiana sugar factories the writer would say that under any condition the heat release per unit volume of combustion space should not exceed 30,000 Btu per hour water walls or no water walls, it being understood that this is under existing conditions.

There have been a number of improvements made in furnace design by various engineers and the ones we feel should be given most consideration are those furnaces wherein the bagasse furnaces have been so installed that there is no throw-over into a rear section of the boiler requiring reinjection of unburned fuel or cleaning out of the rear ends of the boilers which all of you know requires much time and trouble and creates much maintenance as well as increasing labor.

Particular attention is paid to combustion space over and above the bagasse furnaces sufficient to maintain the full desired rating of the boilers without excessive unit volume heat releases when the boilers must maintain full capacity on steam on auxiliary fuel alone.

Some very good bagasse furnaces have this inherent disadvantage of not sufficient combustion space for auxiliary fuel.

Basically in boiler house design we believe that the one thing that has been most neglected in furnace design is the desire to keep elevations of boilers at a low point, many times simply to adjust to the height of an existing building.

We subscribe to the raising of a boiler to provide ample furnace volume regardless if it means raising the roof of an existing building or not. We further subscribe to the elimination of extended Dutch ovens from any boiler setting.

The old idea of the necessity of the so-called "ignition arch" in a drop flat roof over the bagasse furnaces has been exploded twenty years ago. It probably had some value when sometimes in all probability the moisture content of bagasse was up to above 60%.

Therefore, in resetting of old installation or in installation of new settings much thought should be given to proper and adequate furnace design. Whatever this cost, in the long run it is very cheap.

Wall construction of furnaces is of great importance. Only highest quality refractory materials should be used in the "hot zones." Since freight is a goodly part of the cost of refractories very little is saved in erection cost by using a "cheaper" refractory than the best quality.

Our experience has convinced us that suspended wall construction should be used on all furnace walls over twelve (12) feet high. The cost is little, if any, higher in first cost and maintenance is reduced more than fifty per cent by using suspended wall construction.

Suspended walls do not impart the total weight of the wall to the lower courses of refractory and do provide true expansion that is not possible in solid refractory walls.

All furnace walls should be engineered in a competent manner.

This paper would not be complete without discussing boiler feedwater and boiler feedwater treatment as well as boiler feedwater pumps.

We believe that any Louisiana sugar factory should operate the boiler plant on 90% of condensate return with only 10% make-up water. These condensates are available from the juice heaters, the evaporators, the vacuum pans, and any other equipment utilizing steam for heating purposes. Second stage evaporator waters in an evaporator equipped with proper separators for entrainment should be better boiler feedwater than any well water or bayou water, or river water that is available in the Louisiana sugar industry.

The value of the heat in the condensate is a sizeable figure in itself and the fact that no condensate that is a true condensate is scale forming in nature must be taken into consideration.

Improper boiler feedwater forms incrustations on heating surfaces which result in very serious consequences either in the old HRT boilers (which are becoming obsolete) but also in water tube boilers of most modern design. Scale is a loser of efficiency and the cause of burning out of tubes or bagging of boiler drums.

There is no excuse for any scale formation in the boiler plant of any sugar factory that will only recognize the fact that scale formation is not necessary and will have engineers who will give the proper attention to boiler feedwater treatment.

Unfortunately the condition of boiler feedwater treatment and the condition of the boiler waters that exist in the drums or shells of operating boilers is not given sufficient importance in the majority of the Louisiana sugar factories.

Certainly all sugar factories run tests on the condensates to determine if there is sugar in the water because they know that sugar in the water creates foaming conditions in boilers and sometimes actually stops the mill which seems to be the criterion for judging the operation of a boiler plant.

Very often when sugar is detected in the condensate of any vessel that is returning the condensate to the boilers this condensate will be ditched and will continue to be ditched long after it is suitable for return boiler feed. We have seen this many times.

This is an inexcusable practice and is occasioned due to the fact that as long as there is no shortage of water to keep the water level up in the boilers no one seems to give a _____.

This, however, is a very important matter and is just as guilty of poor superintendence or engineering or management as would be the case if a certain amount of the juice being extracted by the mills proper were being sent directly to the ditch and in full sight. There is no difference. Both are disastrous to economic operations but one is observed and the other is not!

Unfortunately we know that there have been many "fly-by-night" water treating companies operating in the Louisiana sugar industry that promise by throwing a block of "so and so" into the boiler feedwater tank now and then that you will never have any further trouble. Furthermore we know that there are various "mysterious" "electronic" "atomic" and otherwise vaguely described water conditioning equipment offered to the sugar industry that are supposed to be cure-alls for boiler scale.

THE AUTHOR WISHES TO GO ON RECORD AS STATING THAT AS FAR AS HE KNOWS THERE HAS BEEN NO MIRACLES PERFORMED IN TREATMENT OF BOILER FEEDWATER AND THAT THERE IS ABSOLUTELY NO BOILER FEEDWATER TREATMENT OR EQUIPMENT IN THE WORLD THAT IS WORTH ONE CENT UNLESS IT CAN EXPLAIN CHEMICALLY, PHYSICALLY, AND REASONABLY THE ACTUAL ACTION THAT IS TAKEN TO PREVENT SCALING OF WATER.

If anyone would care to make a wager of sufficient amount we can arrange one that we can install a queerly shaped section of cast iron in which we would embed an electrical coil of any kind and prepare a vaguely written discussion of the phenomenon that such a piece of farce equipment would offer and through the medium of advertisement would be willing to not only produce the fact that same could be sold at an exorbitant price but also that we could secure letters proving that such a gadget worked and did wonders in that particular plant.

We are gullible to a certain extent to such advertisement but we caution the sugar industry against any boiler feedwater treatment or conditioning equipment that cannot and does not tell exactly what it does and in words that are acceptable and provable by the known fields of engineering--chemically and mechanically and physically, and also approved by the Bureau of Standards of the United States.

No, we are sorry, there are no miracles in treatment of boiler feedwater. On the other hand, the proper treatment of boiler feedwater in Louisiana sugar factories is a SIMPLE MATTER and requires no more elaborate testing than that is carried out for the determining of sucrose in a tail pipe water or in the condensate from a vacuum pan or calandria or the steam coils of any equipment.

Every Louisiana sugar factory should have competent chemical control over the condition of the boiler feedwater just as much as it does over the sugar juices and sugar solutions in process in the factory. This can be done at low cost but it cannot be done in a half-hearted and slipshod manner.

Too many engineers look upon boiler feedwater treatment with a "I don't give a _____ attitude - it's no good anyway." This has some justification for foundation but in modern days is absolutely obsolete and completely erroneous.

There are a dozen or more companies who furnish and offer the industry competent boiler feedwater treatment and proper feedwater treating equipment.

One fallacy of the industry of water treating, however, in Louisiana sugar industry is based on the fear that they cannot "sell" their product if they sell the proper equipment for application because the cost (first cost) would be too high.

IT IS JUST AS WELL NOT TO USE ANY TREATMENT AS TO USE IT IMPROPERLY!!!

Therefore, we subscribe to any adaption of boiler feedwater treatment that is carried out meticulously just as is the pH control of the cane juice to the clarifier (incidentally just as simply) and with the proper equipment.

It is our opinion that a chemical feed pump is required for each boiler that is in operation in a sugar factory if the proper condition of the water within the boilers is to be maintained at zero hardness and with non-scale forming properties.

We wish to go on record that no one can prove the fact that there is any other way in the world to prevent scaling of boilers or other deteriorating effects than maintenance of proper chemical condition of the boiler water within the boiler proper.

Feeding of the chemicals to the feedwater tank does not suffice because the work of the boilers in a sugar factory is not uniformly distributed, as we all know, resulting in some boilers getting more of the chemical treatment than others and establishing disturbed ratios.

For each one part per million of hardness material entering a steam boiler in the feedwater there will be deposited in scale somewhere in the steam generating areas one pound of scale for each million pounds of water evaporated. This is cumulative in nature and can become disastrous before the end of a 65-day Louisiana operating season!

WE REPEAT THAT IT IS A WASTE OF MONEY TO ATTEMPT TO PROPERLY TREAT BOILER FEEDWATER BY ANY MEANS UNLESS IT IS GOING TO BE RESPECTED BY THE KEY OPERATING PERSONNEL OF THE FACTORY AND UNFORTUNATELY WE HAVE SEEN MANY TIMES THAT THIS HAS NOT BEEN THE CASE. IT IS JUST AS IMPORTANT TO WATCH THIS FACTOR AND TO CONTROL THE BLOWDOWN ON BOILERS (PREFERABLY MOSTLY BY CONTINUOUS BLOWDOWN WITH HEAT EXCHANGERS) AS IT IS TO MAINTAIN THE pH OF THE CLARIFIED JUICE OR THE POLARIZATION OF THE SUGAR PRODUCED, AND, AGAIN, REPEATING JUST AS SIMPLE. THE MAIN THING IS TO ACCEPT AND ACKNOWLEDGE THE IMPORTANCE OF SAME.

We have some references that we would be glad to offer where the above statement has proven to be true. We will gladly furnish to anyone who would care to check. Please remember we have no connections whatever with any boiler feedwater treating company in the world.

Another matter we have observed in every Louisiana sugar factory we have visited is the universal tendency to maintain water levels at too high a point. The old water tenders have an idea that unless the gauge glass is at least three-quarters full (commonly called three gauges of water) the boilers are in danger of running out of water. We maintain that this is a poor practice and results in higher entrainment of boiler water with the steam leaving the boilers where superheaters are not employed or would result in plugging of the superheaters where superheaters are employed.

The level of the water in the boiler drum should be below the horizontal centerline of the boiler giving the maximum area for liberation of the steam bubbles. Even with boilers equipped with scrubbing devices, baffles, and other means of eliminating entrainment, it still is advantageous to carry a water level never more than one-half of the height of the gauge glass. We do not know how to correct this malpractice as we have been trying to do it for a number of years, and only in a very few factories have we ever been able to drive over the simplicity and the importance of this.

Properly selected and engineered boiler feedwater regulators of dual operating means do a good job if installed properly. Simple one-stage types do not do a good job in a sugar factory.

As a matter of fact the amount of water in the drum of a boiler between one-half of a gauge glass of water and three-quarters of a gauge glass of water would not keep a heavily steaming boiler in operation more than one or two minutes and is only a small proportion of the amount of water that exists in the boiler tubes proper. If many operators knew that in some conditions the rear drums on multidrum water tube boilers were actually empty of all water when the boiler was operating under heavy loads they no doubt would leave their job, again proving the employment of ignorant people in the boiler plant proper because the boilers are safe.

We have had our "clashes" with representatives of various boiler feedwater treating companies and have run up against their fear that they could not sell their product by doing the job right, and we have not excused them of negligence in this respect but on the other hand since this has definitely been established as pertaining to the one who can say "yes" or "no" in the sugar factories of Louisiana the blame must be placed where it belongs.

There is no use of a factory having a specialized service or consultant unless the recommendation of same are carried out. Any other practice would be simply an easing of conscience at ultimately and much higher cost than would be the results if the job were done properly in the first place.

Most of our Louisiana sugar factories now do operate with centrifugal boiler feeder pumps. There are a few "oldtimers" who having experienced difficulties once with centrifugal pumps handling hot water who still rely on the expensive and inefficient reciprocating pumps for feeding of boilers.

Some comment is in order on the operation of boiler feed pumps. The centrifugal pump, either turbine driven or motor drive, is the ideal boiler feed pump and is universally used in every industry we know of other than our own particular industry. Part of the difficulties experienced in centrifugal boiler feed pumps in Louisiana sugar industry is again due we must state to poor engineering knowledge.

A centrifugal pump after a fashion is no more than a fan which will deliver a certain amount of air under certain conditions. Since water is more or less noncompressible, or incompressible, as air is compressible then the difference between a fan and a centrifugal pump is that the pressure is increased on the water entering the pump when it is discharged.

There are many characteristics of a boiler feed pump that are not given proper engineering study. Each centrifugal pump handling hot water has certain characteristics and while it is not necessary for a factory owner to be an engineer the selection of boiler feed pumps of proper design should not necessarily be left strictly in the hands of a salesman. We repeat there are many salesmen who are really sales engineers and will take the time to study the existing conditions, but we have seen in several large Louisiana factories improperly installed centrifugal boiler feed pumps.

A pump should be purchased having a sufficient capacity to take 150% of the normal load of the boiler plant under maximum conditions. If it is turbine driven it should be provided with a differential pressure governor to slow the turbine down when the pressure reaches a fixed point over and above the boiler operating pressure. If it is a motor driven centrifugal pump the same precaution should be taken in a pressure regulating valve in the discharge of the pump proper.

It is the desire of every sugar factory to have the boiler feedwater at the maximum temperature. Actually this temperature should be in the neighborhood of 230°F. for very many reasons that can be explained but requires too much volume to this already lengthy paper.

In any event, even if the water is only 200° there is a certain condition under which the pump must be designed requiring what is called the "net positive suction head characteristics" of the pump referred to as the N.P.S.H. When a pump is purchased specifying that it requires an N.P.S.H. of 20 feet, this means that the suction of the pump must be provided with a static pressure of 20 feet of water at 60°F. over and above the vapor pressure of the water being pumped into the boilers. If this sufficient N.P.S.H. is not furnished to a centrifugal pump then the water entering the suction of the pump will go under a vacuum condition or a flashing condition for that temperature of water and will cause the pump to vapor-bind and reduce the delivery head materially, or even cause the pump to cease operation entirely due to vapor-lock.

In several factories we know we have seen this condition and we have further seen larger pumps installed where it was not necessary simply because of the fact that the condensate recipient or feedwater recipient was not elevated sufficiently high, and it was estimated that the larger pump was required when such was not the case at all. We have furthermore seen several factories go to a great deal of expense to assure that hot water would be fed back to the boilers only to find on inspection that the engineers had discovered that the boiler pumps would not pump the hot water and as a result, the tank was being allowed to overflow and cold make-up water containing all of the hardness of the source of supply was being allowed to flow into the boiler feedwater recipient to reduce the temperature even after it had been heated up so that the pumps would not vapor-bind.

There are other very important engineering data needed for proper selection of a boiler feed pump than the temperature of the water. They are:

1 - The pH of the water. (Necessary to select proper materials in the pump manufacture).

2 - The maximum and minimum quantities (within reasonable limits) to be pumped.

3 - The minimum pressure pump will operate under.

4 - The average discharge pressure (50 lbs. per square inch above boiler pressure on boilers up to 250 psig pressure).

From (2), (3), and (4) the engineer can select from known performance curves a pump that will not overload the electric motor (if used) should the pressure drop and otherwise complete the necessary engineering to select exactly the correct pump and drive for it. A performance curve on every centrifugal pump in a sugar factory should be on permanent file in the engineer's and manager's office.

These are all simple matters if given proper attention.

Very often we believe it might be to the advantage of a sugar factory to lift their condensates by a secondary pump if necessary (we have practiced this in several factories) rather than to be faced with having insufficient net positive suction head on the boiler feed pump.

We invite any discussion of this subject either at this meeting or by correspondence without any obligations whatsoever as we wish to clarify any statements we have made that are vague or misunderstood.

There are many other matters pertinent to boiler house practices in Louisiana sugar factories that deserve discussion but having already far exceeded the time allocated to this paper we apoligize for omitting many factors. One or two of these should be mentioned, however, and that is that any worthwhile sugar factory, (I consider all factories worthwhile) should give serious consideration to the following:

Instrumentation

Instrumentation to a great extent is neglected in Louisiana sugar factories as factories operate even without draft gauges to say nothing of the absence of other very important meters to judge the efficiency of operation of a boiler plant.

We regret to advise that several who have installed metering equipment, draft control equipment, and draft indicating equipment have allowed this equipment to become null and void in value insofar as the engineers have allowed the lines to become plugged and the instruments are completely inoperative. An instrument is not an ornament. Unfortunately this has been permitted to be the case in several instances very close to us and we consider the instruments in a boiler factory just as necessary as the instruments on vacuum pans, evaporators, clarifiers, the laboratory - or to a doctor in order to determine the condition of a patient.

We consider the recording of stack temperature, the recording or indicating of steam flows, the recording of draft, and the regular reading of flue gas analyses absolutely essential to proper operation of a steam generating plant. This applies to the sugar industry just as well as it does to any other chemical industry in the United States, but we believe that the Louisiana sugar factories are the only ones who ignore this fact.

We do not subscribe to over-elaborate control equipment of automatic nature in Louisiana sugar factories but we do believe that a certain amount is the best investment a sugar factory can make provided, again, it is kept in operation and maintained according to the directions and any man capable of being chief engineer or superintendent of a factory can keep such instrumentation at proper operating conditions if his heart is in his work.

Boiler House (Steam Generation) Records

Without instrumentation naturally records are not available, however, with a minimum amount of instrumentation averaging approximately $1000.00 per boiler in operation it would be easy for the laboratory to render a daily report showing the pertinent factors that are important to efficient operation with respect, for instance, to the amount of steam required per ton of cane ground as metered on operating steam meters. This could be a very simple report and not require the addition of any personnel but simply the addition of some relatively simple and low priced metering equipment.

For the interest of those listening to this paper or reading this article this practice is carried out in several sugar factories outside of Louisiana where we are connected and we would be glad to furnish any sugar factory with a basic form for recording this vital information if so requested. Naturally, each factory has a separate condition and the same form in verbatim could not be reproduced. If provided with the necessary information we will be glad to assist the owners, engineers or superintendents of sugar factories with the proper type of accounting that should be employed in boiler house operations and without obligation.

It would be a mistake in our opinion in the presentation of a paper of this length not to mention briefly several factors with respect to disposal of bagasse to commercial means other than fuel.

Since more than a thousand papers have been prepared on this subject we certainly do not have the time nor the disposition to discuss them other than propounding a few facts.

It is the writer's opinion that there has been more promotion rather than development in the use of bagasse for industrial purposes other than fuel.

It has been definitely established that bagasse is well suited to the manufacture of many paper products.

It is definitely established that there is in operation in Louisiana one plant that utilizes bagasse for paper products satisfactorily.

It is definitely established that in several other countries throughout the Western Hemisphere there are several plants utilizing bagasse for the manufacture of paper products.

It is a foregone conclusion that the entire bagasse produced by the Louisiana sugar industry and for that matter the Florida sugar industry could be utilized in a single paper plant to produce marketable products. We do not care to discuss just what these products would be.

It is definitely known that the yield of high quality pulp from bagasse is below that of the commonly known pulpwood but within recent years the cost of pulpwood to paper manufacturers or pulp manufacturers has more than quadrupled in cost and we doubt that any real economic study has been made due to lack of funds to actually demonstrate the fact that bagasse can now in all probability compete favorably both from quality standpoint and from cost standpoint with the present supply of pulp and raw materials.

It is suggested through this medium that possibly one of the reasons more progress has not been made is due to the laxity on the part of the Louisiana sugar manufacturers who would be unwilling to commit their bagasse to a new industry which would cost in our opinion no less than $30,000,000.00 which could process practically all of the bagasse produced in Louisiana.

Naturally, no one can expend any such sums without assurance of raw products. The thought is advanced that the sugar industry could cement itself together and provide a study determining the present cost of paper producing materials and compare the cost or value of bagasse as a competitor to this source of paper supply.

A centrally located paper plant could handle the entire bagasse production of the sugar industry in Louisiana but being so many facets to a diamond someone cannot see the single stone. It does take all of these facets, however, to make a gem and they all must be together and unless the entire Louisiana sugar industry would combine in this direction we anticipate many more years of burning a product that we are convinced is more valuable than its fuel value. It should be employed for industrial reasons and reduce the demand on our forest which could then be employed to produce lumber instead of paper pulp stock.

Before passing from this deviation from this paper we wish to point out that no industry could possibly be overly enthused in a capital expense of $30,000,000.00 unless before entering into such a study they had the basic assurance that they could secure their raw products for a period of not less than 25 years and at an established price in comparison with the cost of other sources of the same raw material.

We reiterate our opinion that bagasse in Louisiana to a paper producer could be sold competitive to wood pulps at present day labor and materials cost to the advantage of the Paper Industry and the Sugar Industry if there were any central power of authority in the Louisiana sugar industry.

It is the purpose of this paper to instill more thought with respect to the importance of the Boiler House Steam Generating Plant in the minds of the owners, management, superintendents, and engineering than has been given in the past.

If any item in this paper inculcates such an interest then our time will have been well spent.

It is recognized by us that many factors have not been covered that should be covered but a book cannot be presented in a paper form. If we succeed in bringing out the importance of more attention to the steam plant and in any single instance remove it from the "Orphan Annie" or "Stepchild" category in one single sugar factory we will well have accomplished our highest desire with respect to this presentation.

FRESHER CANE INCREASES SUGAR RECOVERIES AND PROFITS FOR BOTH GROWERS AND PROCESSORS

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ABSTRACT

The steadily declining trend from 1939 through 1952 in the percentage of the total sugar in cane recovered by the factories raised serious doubt of continued prosperity of the Louisiana sugar industry. Calculations from the recapitulated results of operations of all factories for the 14-year period (1) showed that this trend, if continued, would bring the percentage recovery of sugar down from 80% in 1939 and previous seasons to only 70% by 1956 (2). The recovery was less than 75% of the sugar in cane in the 1952 crop. Fortunately the downward trend did not continue and recoveries of 75-76% have been realized in the latest seasons for which recapitulated factory results are available (3). Fresher sugarcane delivered to the mills more promptly after harvesting and in cleaner condition has contributed much to maintaining better recoveries in the last two crops, although increased production of the superior C.P. 44-101 cane and favorable growing and harvesting weather have helped in achieving this result.

Further improvement in delivering cleaner cane as soon as possible

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after harvesting should reverse the trend and raise the recovery of sugar by the factories to the 80% that was common before it became necessary to harvest mechanically. The sugar content of cane has varied from season to season with no significant trend up or down from approximately 210 lbs. of 96 test raw sugar per ton. Experiments carried out during the 1954 and 1955 seasons on the effect delay in grinding harvested cane under practical field and factory conditions showed that a considerable increase in available sugar can be expected when the average delay in grinding cane is reduced to less than 48 hours (4). Growers will benefit from increased amounts of available sugar in cane delivered promptly, and factories will profit by the actual recovery of a larger percentage of the sugar in the fresh cane. New varieties, such as C.P. 48-103 which matures early and has a high sugar content, should produce 200 lbs. of 96 test raw sugar per ton if ground as soon as possible after harvesting.

Rising processing costs make it more important than ever for factories to process cane that will produce the maximum amount of raw sugar per ton of cane milled. Efferson and Cobb (5) determined in 1949 that fixed overhead made the processing of cane yielding 150 lbs. of raw sugar marginal or unprofitable. Costs have risen since then, so that it is necessary to obtain more than 150 lbs. per ton to realize an adequate profit on prices that can be expected for raw sugar and molasses. In addition to loss from greater overhead costs per ton of sugar produced, stale cane cannot be milled as efficiently.

Extraction is lower, the juice is more difficult to clarify, and larger quantities of mud must be handled with more filtrate returned to clarifiers. This results in further loss, because actual recoveries are less than the theoretically available sugar paid for. The longer operating season required to produce a given quota of sugar from the low recoveries obtained from stale cane increases the losses from inefficient extraction and clarification, and from excessive overhead costs.

Tables 1, 2, and 3 show estimates of the losses for increasing periods of delay in grinding harvested cane for growers on operations of various acreages, and for factories operating at different capacities.

InTable 1, columns 1 and 3 show the sugar recovery from 1 ton of cane on the day the cane was milled in 1954 and 1955. Columns 2 and 4 give the values for 1,000 tons of cane corresponding to the sugar. Column 5 shows the values for 1,000 tons of cane calculated from the 1954 and 1955 experiments for every day from the 1st to the 11th day after harvesting. Column 6 gives the losses in dollars to the farmers for any delay in delivering cane beyond 36 hours after harvesting.

Table 2, column 1, shows the increase in the number of days to grind the sugarcane to produce 10,000 tons of sugar due to the decrease in sucrose content in the cane, because it requires a larger amount of sugarcane to produce the same quantity of sugar. Column 2 shows the calculated values, obtained from data on the cost of sugar production for different sucrose contents in cane given by Efferson and Cobb for producing a quota of 10,000 tons of sugar, and column 3 shows the losses due to milling cane 36 hours after harvesting.

In Table 3, columns 1 and 2 give the losses to the farmers and factory owners in Louisiana based on the cane and sugar produced in 1955; in column 3 is the total loss to the sugarcane industry in milling sugarcane for any delay beyond 36 hours after harvesting.

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Table 1

Value of 1,000 T. Sugarcane

	1954		1955		1954-1955	
	1	2	3	4	5	6
Days Old	Avg. of 6 Tests (lbs.)	Farm Value for 1000 T.	Avg. of 8 Tests (lbs.)	Farm Value for 1000 T.	Farm Value for 1000 T.	Losses after 36 hours
1	150.8	$7104.00			$7100	
1-1/2					$6880	0
2			146.4	$6628.00	$6480	$ 400
3			134.3	$5924.00	$6080	$ 800
4					$5830	$1050
5					$5610	$1270
6					$5420	$1460
7			121.8	$5011.20	$5260	$1620
8					$5140	$1740
9	133.6	$5214.00			$5030	$1850
10					$4940	$1940
11			112.6	$4695.00	$4850	$2030

Table 2

Factory Loss
2000 Ton Daily Capacity with a 10,000 Ton Sugar Quota

Days Old	Recoverable 96^{o} Sugar in Cane	Days Required to Produce 10,000 T. Sugar	Total Cost to Produce 10,000 T. Sugar	Loss from Delayed Milling
0				
1		36 Hours Allowed Before Milling		
1-1/2	146.1	68.5	$1,370,000	$ 000
2	142.0	70.5	1,434,000	64,000
3	139.0	72.0	1,480,000	110,000
4	136.5	73.3	1,520,000	150,000
5	134.0	74.7	1,556,000	186,000
6	131.5	76.1	1,596,000	226,000
7	129.0	77.6	1,634,000	264,000
8	126.5	79.1	1,672,000	302,000
9	124.0	80.7	1,712,000	342,000
10	121.5	82.4	1,748,000	387,000

Table 3

Loss to the Sugarcane Industry

(Based on 1955 Production - 5,660,000 T. Cane and 455,000 T. Sugar)

Days Old	Losses to Farmers	Losses to Factories	Total Losses to Sugar Industry
0			
1			
1-1/2	0	0	0
2	$2,264,000	$ 2,912,000	$ 5,176,000
3	4,528,000	5,000,000	9,528,000
4	7,188,200	6,825,000	14,013,200
5	8,263,600	8,463,000	17,926,000
6	9,169,200	10,283,000	19,452,200
7	9,848,400	12,012,000	21,860,400

FILTER PRESS OPERATIONS

J. T. Landry, Jr.

Starting in 1953, South Coast at Georgia Factory operated six (6) 36"x36" center feed filter presses handling clarifier mud.

A detailed report of this operation was presented to this Society in 1954 by Mr. H. J. Jacobs. In this report Mr. Jacobs stated that the projected savings against the rotary vacuum filter in sugar was $.2154 per ton. The cost of the press operations including both labor and cloth cost was $.06788, giving a net savings of $.14452 per ton.

As a result of these operations in 1954, South Coast installed at Terrebonne Factory eight (8) 36"x36" 750 sq. ft. plate and frame filter presses. The plate and frame design was selected rather than the center feed because of cloth economy, as well as ease of dressing. The frames at Terrebonne are 1-1/4" thick which gives the units 39 cu. ft. holding capacity. The presses are equipped with hydraulic closing devices. The filter cloth used is 21 oz. cotton twill, which is purchased in rolls and is cut to size at Terrebonne.

The 8 presses at Terrebonne are operated by a crew of five men per shift, which consists of one foreman and four press men. This crew tends to the dressing and washing of all cloths. Cloth repair is handled by two women on an 8-hour basis using industrial type sewing machines.

Mud from the clarifier with a small amount of lime added is sent to a receiving tank. The presses are fed mud directly from this tank. For starting a 2" motor driven centrifugal sand pump, which maintains a pressure of 10 to 15 psi, is used. When the presses are full of mud and the filtrate flow rate begins to drop, they are then switched to a high pressure system of 40 to 45 psi which is maintained by a duplex ball valve steam pump operating on a pressure governor. With the two pressure system the danger of smearing or blinding the cloths is lessened. The length of cycle is from 2-1/2 hours to 4 hours depending on mud conditions. The dumping or cutting operation takes two men from 18 to 20 minutes. This time is measured from the time that the feed valve is closed to the time that it is opened for the next cycle. When a press is to be dressed the total down time is approximately 45 minutes.

The cloths are washed every 4 to 6 days, depending on mud conditions. The washing is done in a horizontal tumbler washer using only hot water.

The filtrate from the presses goes direct to the evaporator with no filtrate returned to the clarifier. The spillage from leaks on broken cloths is sent back to the mud tank that supplies the presses. The mud from the presses is discharged into a slat conveyor which delivers it to a bin. From the bin the mud is taken by a hopper type spreading wagon direct to the fields.

Listed below is a table that shows the pertinent figures for the last two years that the rotary vacuum filter operated, as well as the last two years that the presses operated.

FILTER COMPARISON

Terrebonne Factory

Type Unit =	Rotary Vacuum			Filter Press			
			Simple Ave.			Simple Ave.	
Year	1952	1953	52-53	1955	1956	55-56	Diff.
Cane Ground	174 705	179 624		183 197	147 782		
Cane/Day	1 839	2 164	2 002	2 544	2 423	2 484	+ 482
Lbs. Mud/Ton	99.70	136.77	118.24	55.64	51.09	53.37	- 64.87
Suc. % Mud	5.58	6.82	6.20	5.36	6.15	5.75	- .44
Mud Loss Suc. % Cane	.278	.469	.379	.149	.157	.153	- .226
Lbs. Suc. Loss/Ton	5.56	9.38	7.58	2.98	3.14	3.06	- 4.52
Press Juice Purity				76.14	79.61	77.88	
Man Hours Labor				9 953	8299	9126	+ 9126
Labor Cost				8635.49	8448.10	8541.80	+8541.80
Cloth Cost				4935.56	852.92	2894.24	+2894.24
Total Cost				13571.05	9301.02	11436.04	+11436.04
Total Cost/Ton				.0740	.0630	.0685	+ .0685

Retention on 77.88 Purity Press Juice using 97 Purity Sugar and 30 Purity Final Molasses equals 89.01

4.52 x 89.01 - 4.023 Lbs. sucrose
4.023 x 97 BHE - 3.90 lbs. sucrose

$\frac{3.90}{96} = 4.06$ lbs. 96^{o} Sugar

Value of Sugar at $.06 per lb.

.06 x 4.06 = $.2436 Value of sugar saved & retained
$\underline{.0685}$ Cost of labor & materials
$.1751 Net Savings

Please note that the figures for 1954 are omitted. The omission is intentional since the rotary vacuum filter was operated in conjunction with the presses that year. Because of this dual operation the final crop figures cannot be used in a comparison.

Please note from the above table that with the same clarification equipment (One 20 ft. 4 tray Dorr and one 18 ft. 3 tray Dorr) the grinding rate was increased 482 tons per day while the mud loss % cane was reduced by .226. This decrease in mud loss amounted to 4.52 lbs. of sucrose per ton. When this is converted to 96 sugar, by the retention formula, it amounts to 4.06 lbs. which gives a net savings of $.1751 a ton after deducting labor and material costs.

The South Coast Corporation is pleased with the savings in operation of the presses but is not satisfied with the amount of labor required. For this reason we are still looking for a filter that will duplicate the press operations but with a minimum of labor. With this in mind, we have been working with a filter company that is trying to develop such a unit.

WEIGHING OF SUGAR ON CONTINUOUS BELT CONVEYOR TYPE SCALES

J. T. Landry, Jr.

In 1952 South Coast installed in its raw sugar factories, Oaklawn and Terrebonne, belt conveyor scales to weigh bulk raw sugar as it was produced. Our raw sugar is shipped via barge (approximately 500,000 pounds per barge) to our Georgia Refinery. At the same time as these scales were installed, we also installed at the Refinery a truck scale to weigh the raw sugar as it was unloaded from the barges. The refinery weights obtained from this truck scale are the official weights for the transfer of this raw sugar from the raw factories to the refinery. With this setup, it was quite easy to get a complete check on the belt scales.

The belt scales were installed with endless belts and equipped with motor driven rubber belt brushes for cleaning. These scales were tested with the test chain and found to be operating and apparently weighing satisfactorily. However, as soon as the raw factories received their refinery weights, it was evident that there was some discrepancy in the belt scale weights.

In the case of Terrebonne where we have no sugar storage facilities and the refinery weights are obtained weekly, this was not too important, but in the case at Oaklawn where sugar was stored and final refinery weights were not obtained until after the crop, the weights are very important.

For this reason we worked very hard to obtain accurate weights at Oaklawn. The scale representative's mechanics worked very closely with us but could not obtain consistently accurate weights with their normal procedure. Oaklawn then set up the following testing procedure to obtain a factor to apply to the scale recorded weights. Sugar (approximately 10,000 pounds) that was run over the belt scale was dropped into wheeled dollys with built up sides and weighed on an existing 5,000 pound capacity platform scale. The dollys and platform scale are a part of our turbinado sugar handling equipment. The platform scale weights were compared with the belt scale and a correction factor for the belt scale was obtained. This factor varied from time to time but averaged approximately 3%. The factor calculated was used until another test was made and a new factor obtained. By using these factors, the final production figures are within 1% of the refinery weights.

It is the opinion of the writer that the weight error of these scales are due mostly to the fact that we do not keep the scale belts absolutely clean. The rubber belt brush mentioned above does a nice job of keeping the belt clean but even this is not 100% effective. The weather conditions have considerable effect on the effectiveness of the belt brush and as a result the accuracy of the scale.

The pre-grinding testing of these scales with the test chain is essential but this is definitely not sufficient to obtain accurate weights. Please bear in mind that when this pre-grinding test is made the belt is clean. As soon as sugar is carried by the belt there is some slight buildup of sugar on the belt. For this reason the normal error in a belt scale is plus - that is, the scale records more weight than actually goes over the belt.

Belt scales are fine labor saving devices but they require periodic checks. It is the writer's opinion that these scales should be checked against dead weight scales at least once a week and the appropriate factor applied against the belt scale weights.

WEIGHING OF SUGAR ON CONTINUOUS BELT CONVEYOR TYPE SCALE

Irving E. Legendre, Manager
LaFourche Sugar Company, Leighton Factory
Thibodaux, La.

Bulk Sugar Handling System at Leighton Factory

Shortly after the close of the 1950 grinding season the management of the LaFourche Sugar Company made arrangements for shipping sugar in bulk. Since the "over-quota" sugar was not yet a problem, provision was made for storing only one day's production of approximately 600,000 pounds of raw sugar. It was deemed advisable at that time to provide for shipping both by truck and rail and still be able to bag, if necessary. A steel hopper bottom bin 20 feet wide by 40 feet long, of approximately 600,000 pounds capacity, was installed adjacent to the existing raw sugar elevator replacing the bagging bin. The elevator was heightened approximately ten feet to insure proper discharge at the top of the bin. The sugar from the elevator discharged directly into a 14" diameter open bottom ribbon conveyor which ran over the bin to distribute the sugar the full length; this was operated by a 15 HP electric motor. The existing bagging bin was relocated at the end of this conveyor to be used in the event it was necessary (the bagging hopper has since been removed).

Under the new storage bin we placed a 14" ribbon conveyor in a flared trough, operated by a 25 HP electric motor. This conveyor is fed by a series of hand operated rack and pinion slide gates built onto the bottom of the bin. This reclaim conveyor can discharge its sugar into trucks, or carry it to the inclined belt conveyor which we installed in 1953 when we built our warehouse. This belt conveyor has a continuous weighing scale and discharges just past the building wall.

Early in 1953 it became evident that a large storage warehouse would be desirable, consequently one was constructed measuring 110 feet wide by 185 feet long, by 27 feet to the bottom chord of the roof trusses. In order to realize the full capacity of this warehouse, approximately 30,000,000 pounds, additional conveyors were installed. An inclined belt of 22 degrees, 50 feet long from center to center, 18 inches in width, operated by a 3 HP electric motor, was installed. The inclined belt receives from the scale belt and delivers to the reversible shuttle belt running down the center of the warehouse. A belt slinger is placed under the discharge of the shuttle conveyor belt to stack the sugar in the warehouse. The scale belt can still deliver to the railroad belt if, and when, necessary.

For reclaiming the sugar from the warehouse during or after grinding, a gasoline scoop-type bucket is used. The screw conveyor under the centrifugals was lengthened, and the scoop loader dumps into this screw on the far end of the elevator which in turn returns it to the shipping bin by way of the elevator. Thus the sugar from the warehouse can be shipped by truck or rail the same as normal shipping during the grinding season.

Continuous Belt Conveyor Scale

It can be seen from the above explanation that any sugar that is either stored in the warehouse or shipped in box cars must necessarily go over the belt conveyor scale. This continuous belt conveyor scale is a Fairbanks-Morse, 75 tons per hour capacity, using a 24" rubber belt troughed. The belt is operated at 106 feet per minute, powered by a 3 HP motor, 1725 RPM, with a reduction of 26 to 1. The scale is mounted approximately midway on a 36 foot conveyor, at 18 degrees.

Method Used to Check Belt Scale and How Often

It has been our custom to get a Fairbanks-Morse mechanic to check the scale prior to each grinding season. In this way we are assured that it has been properly balanced and that it is in good working order.

At the beginning of the grinding season, when we start storing sugar in the warehouse, we check the scale when it has reached approximately 10,000 pounds. With the flow of sugar cut off, in all probability the scale will register a slight increase in weight due to the adherence of the sugar on the belt. The scale then can easily be balanced by moving the counter weight very slightly on the lever arm located inside, so that when the belt is operating the scale will not register. Each time, before putting sugar in the warehouse, the scale is tested so there will be no gaining of weight. In order to avoid a percentage of error we prefer to run the scale at maximum capacity and with no stoppages, and since approximately 50% of our daily output of sugar is shipped by truck and the other 50% is stored in the warehouse, we prefer to use the morning for truck shipments and the afternoons for warehouse storage until the bin is liquidated.

Accuracy of Scale

Just how dependable these scales are can be appreciated by our actual records. We quote figures from our last four years of operation:

Warehouse Record

	Sugar In	Sugar Out	Difference
1953	14,259,520	14,147,820	111,700
1954	14,111,480	14,049,700	61,780
1955	19,654,201	19,632,551	21,650
1956	13,801,040	13,702,810	98,230
	61,826,241	61,532,881	293,360

Withdrawn.. . . . . . . .99.53%
Difference . . . . .47% (Part of difference caused by losses in shipment, left on floor, etc.)

We feel that we have a complete, yet simple and relatively maintenance free system of weighing our sugar which has given us wonderful satisfaction thus far.

PART II - 1958

THE PROPER MAINTENANCE OF FARM EQUIPMENT

Robert J. Anderson

Proper care of farm equipment can pay big dividends. Not only is this true from the point of money saved by attending to small jobs before they grow big, but by the greater efficiency that is obtainable from equipment in good operating order. This is a fact that should not be overlooked in maintenance of tractors, harvesters, cultivators, applicators for fertilizer, trucks and tires. Tractors that are operated in the field, steaming and overheating are not efficient, and unless attended to will soon need extensive repairs. The same would be true of a harvester that is being run with worn chains, sprockets and bent rails. This trouble will have to be corrected, and if not corrected soon enough will often cause other repairs that would have been unnecessary if the original trouble had been attended to in time.

Cultivating equipment that does not do a satisfactory job and has to be stopped frequently for repairs is expensive. Fertilizer must be applied uniformly and on the row, not the headland. A truck that knocks, spits, sputters and misses, will not give it's full power. If allowed to continue in this condition will soon be headed for a shop and a large repair bill. The tire that is rolling underinflated is heavier to pull and is subject to irreparable damage. A tire, truck, fertilizer applicator, cultivator, harvester, tractor or any one of the many pieces of equipment that is neglected and allowed to operate without essential repairs, is not only inefficient, but often a hazard to the operator.

Many will say, it is too expensive to recondition all my equipment. It probably would be very expensive if it was all done at one time. It can be done in a systematic manner, repairing that which is in the greatest need first, then gradually working through the rest of your implements. To be effective this program should be carried out on a continuous basis and not just when it is convenient. This plan would call for the complete cooperation of each individual that is in any way connected with the operation and maintenance of your equipment. It should also include definite schooling and instruction for your operators and mechanics.

There is a quirk in human nature that makes it easy to lead individuals, but hard to drive them. Any plan to be effective must have the backing of those individuals that are part of it, and their wholehearted desire to see it succeed. This cannot be accomplished by letter, directive or orders. It can be brought about by first making these individuals take pride in themselves, their equipment and their work. It is an indisputable fact, that to do good work the workman must have good tools to work with. It is just as true that an uninstructed workman is incapable of obtaining the best results from his tools. I am sure that some program for farm labor instructions and schooling, could, and would produce surprising results.

Having spent 15 years servicing and maintaining automotive equipment, I have seen what can be accomplished where preventive maintenance is practiced. Having spent 25 years checking and inspecting fleets of tractors and trucks, I have also seen what can happen when small troubles are ignored and allowed to grow to big jobs.

I would like to give you some idea of how maintenance can effect your operational costs. As I am familiar with tire costs, I will give some figures pertaining to this, based on unused portion of life left in tractor tires when they are discarded. It is a rare thing to find on larger plantations, tires that are discarded because they are worn out. On some plantations many tires are discarded when they still have 50% of the original tread life still left on them. They are losing fifty cents of their tire dollar, one-half of their tire dollar goes on the junk pile. Some may get 60% of the original life from their tires. They still throw away forty cents of their tire dollar. Many of the smaller farmers get 80 to 90% of their tire dollars. This was considered very good until I had the opportunity of going over the equipment and purchases of one individual. This man operates 35 pieces of equipment using large cane field type tractor tires, 30 cane wagons using regular wagon tires. His purchase for this equipment in 1957 was one large tractor tire. In 1956, two large tractor tires and three wagon tires. He has come about as near as it is possible of getting 100% of his tire dollar. This man has become care conscious, not only is he getting the maximum of his tire dollar, he is also getting a larger percentage of his tractor repair dollars. Usually, only the small farmers receive dividends from being care conscious. If they can do it, certainly the larger farmers can do the same. One large farmer has demonstrated that it can be done, and that care does pay big dividends.

Often the question of the use of water in tractor tires arises. Apparently it has never been answered to the complete satisfaction of many tractor owners. I neither condemn or advise its use. I would only advise that the following facts be considered before a decision is made. The low pressure pneumatic tractor tire has proved to be an outstanding success in sugar cane cultivation and harvesting, because it has had so many characteristics that are essential to economical and efficient operation of tractors in this field. The absorbtion of shocks and jars; flotation; greater ground contact area; operation of higher speed; greater economy; ease of movement from job to job; ability to conform to ground contour and objects that they may come in contact with; has proved the worth of tires of this type. Air is compressible. A certain volume can under pressure be reduced and contained in a smaller space. This is what happens when a low pressure pneumatic tire strikes an obstruction. The air space inside the tire is reduced by the enveloping action. As the air space is reduced air pressure is raised compressing or forcing it into a smaller space. This is accomplished without putting undue strain on its container, as being compressible it is able to contain itself without causing excessive rise in pressure. It generates no friction; it is static; it requires no energy to put it in motion; it has no appreciable weight, so it diffuses itself equally at all points in the tire.

With water we have an entirely different substance, Water under pressure is considered the same as a solid. In volume it cannot be forced to contain itself in a smaller space, even under high pressure. When pressure is raised high enough, it will either stretch or rupture its container. Water creates friction. It requires energy to place it in motion and it needs energy to stop its motion. It has weight and this weight must rest on some portion of the tire. It must stretch or rupture the tire when forced into smaller space. In certain instances water may be useful, where additional weight is needed or where greater traction is desired and the vehicle is operated at low speeds. Even then it should be used with caution and enough air left to cushion or absorb any change that might occur in its volume.

THE EFFECT OF GIBBERELLIC ACID ON THE GROWTH OF SUGARCANE[1]

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Among the most interesting plant growth stimulants that have been discovered are the gibberellins. Although these substances were known to the Japanese as early as 1926, it was not until recently that they attracted the attention of plant physiologists in the United States. The gibberellins are substances produced by the fungus, Gibberella fujikuroi, which causes a disease of rice, and at present there are at least two of these gibberellin compounds, gibberellic acid and gibberellin A. Many growth stimulatory phenomena have been attributed to these compounds. The most obvious is that of elongation of internodes. Other responses have been parthenocarpic fruit development in tomato and earlier flowering in several plants (1); the replacement of the cold requirement for flowering in certain plants (2); restoration of normal growth to dwarf mutant maize plants (3); and the breaking of dormancy in many plants. The recent literature actually contains hundreds of references to other growth effects upon specific plants. The literature through 1956 has been adequately reviewed by Stowe and Yamaki (6). More recently, monographs have been prepared by producers of gibberellin compounds (7) (8).

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[1] The gibberellic acid used in this study was most generously supplied by Dr. John D. Garber of Merck, Sharpe and Dohme; Mr. H. F. Seeland of S. B. Penick and Co.; and Mr. L. F. Bewick of Vesicol Chemical Corporation.

This report covers only effects of gibberellic acid on sugarcane as observed in experiments conducted at the U. S. Sugarcane Field Station at Houma, Louisiana. There is a report from Puerto Rico (4) of the effects of gibberellin on sugarcane. Workers there soaked sugarcane seed pieces in solutions of various concentrations of gibberellic acid. Following such treatments they reported increases in growth of from 40 to 100 per cent. Similarly, reports from Hawaii (5) have shown that gibberellic acid solution applied to the spindle of sugarcane plants caused a 50 per cent increase in height as compared with untreated plants. Boume (7) has reported similar growth effects and an increase in rate of germination of seed pieces following a dip in gibberellic acid solutions.

The studies reported in this paper followed several lines of investigation. In greenhouse experiments the effects of gibberellic acid as seed piece treatment and as a foliar spray on young plants were studied. In the field the gross effects of repeated foliar sprays upon growth and yield were studied. Gibberellic acid was also applied in the field as a preharvest treatment, and its effect upon sucrose content of sugarcane for milling measured. Since some of these tests and results of other workers (9) have shown that the gibberellins are able to promote growth in cool weather, the effects of foliar sprays upon growth in the field during November were studied.

In one of these experiments single eye seed pieces were treated by soaking for 5 hours in solutions containing various amounts (5 and 10 ppm) of gibberellic acid. The cuttings were then incubated and planted in

4-inch pots in the greenhouse. Another lot of seed pieces was treated by applying a 1000 ppm lanolin paste of gibberellic acid to the nodal zone. Varieties C.P. 44-101 and C.P. 44-155 were used in these tests, 100 plants being used for each treatment. The effect of the gibberellic acid treatments upon the height of the plants is shown in Figure 1. In Figure 1 the average height of all the treated plants is compared to the average height of the control plants for C.P. 44-101. The growth patterns for the plants of C.P. 44-155 were essentially the same as those shown in Figure 1. The weekly height measurements did not show significant differences between the various concentrations of gibberellic acid used in this test. For the period up to 23 days after treatment, the treated plants increased in height, on an average, at a 56 per cent greater rate than the control plants. After this period the rate of growth of the treated plants appeared to level off while that of the control plants continued at the same rate. By the 47th day after treatment there was very little difference in the rates of growth between the treated and control plants, although the treated plants were taller. At this stage of growth a group of the plants from each treatment was sprayed with a 10 ppm gibberellic acid solution. This treatment resulted in a second increase in rate of growth over that of the previous treatments (see Figure 1). However, 21 days after this second treatment, the rate of growth of all the treatments was nearly the same. Subsequent spray treatments were given at 21-day intervals to the same groups of plants. These repeated treatments carried through 112 days produced 60 per cent taller than the control plants.

The plants which were treated only by soaking in gibberellic acid solutions were harvested 112 days after treatment and height and weight measurements obtained. These results are summarized in Table 1. After this period of growth there were no significant differences in height due to the gibberellic acid treatments. With variety C.P. 44-101, there were significant differences in the fresh weight of the plants. Hence while the single application of gibberellic acid as a seed-piece treatment caused more rapid elongation in the earlier stages of growth, it also resulted in more spindly plants. This is reflected in the data of Table 1 which show that the untreated plants of C.P. 44-101 had a significantly greater fresh weight. When gibberellic acid is applied repeatedly it affects the plants by an increase in both height and weight.

Table 1. Effect of soaking seed piece in gibberellic acid solutions of various concentrations for 5 hours upon the height and fresh weight of two varieties of sugarcane.

	Average height (cms.)		Average fresh Wt. (gms)	
Treatment[1]	C.P. 44-101	C.P. 44-155	C.P. 44-101	C.P. 44-155
5 ppm G. A.	31.4	30.2	35.9	33.5
10 ppm G. A.	34.3	30.0	38.5	32.6
1000 ppm lanolin paste	36.4	-	44.2	-
Water	33.8	29.7	51.8	37.0
Untreated	33.5	-	49.4	-
	n.s.	n.s.	LSD .05 = 1.2	n.s.

In field experiments, foliar sprays of gibberellic acid were applied to plants of variety C.P. 44-101 in 12-ft. x 15-ft. replicated plots. These applications were repeated at 10-day intervals throughout the growing season from April 19 to October 4, 1957. When the plants were young, solutions of 10 ppm were applied and as the plants became larger the concentration was increased to 20, 40, 50, 70, and 100 ppm. The application rate was 100 gallons per acre. Growth measurements of individual plants were taken at regular intervals during the growing season. The results of these measurements are plotted as the mean height of the plants in Fig. 2, and as increments of growth in Fig. 3.

The data presented in Fig. 2 show the cumulative effect of the smaller growth increases upon the total height of the plants at harvest. It also shows the greater rate of growth of the treated compared to the untreated plants during the months of September and October. In Fig. 3, where the periodic growth increments are plotted, several interesting results are evident. During the early growth period, April 19 to June 17, when rainfall was about average and mean temperatures were normal, the treated plants showed a one-inch increase in height over the untreated plants for each period. During the period June 17 to 28, the treated plants increased in height two and one-half inches more than the control plants. Rainfall was sufficient during this period but mean temperatures were several degrees below normal. The greatest growth difference between treated and untreated plants (4.5 inches) occurred between the period June 28 to July 23.

During this period there was actually a rather severe drought with no rainfall from June 28 to July 17, and soil moisture levels at 18-inch depth actually dropped to 18 per cent available moisture. During the next 20-day growth interval the untreated plants showed a greater increase in height than the treated plants. This period was marked by sufficient rainfall and maximum mean temperatures which are characteristic of the growth peak reached each season. As mean temperatures began to decline during the period August 26 to October 16, once again the gibberellic acid treated plants showed significant increases in height over the control plants.

The data obtained on harvesting this experiment are shown in Table 2, test A. Determinations were made of stalk height, weight, and diameter, length of millable cane, number of nodes, length of nodes, and yield of millable cane. The juice was analyzed for total solids and sucrose. Since floral initiation occurred during this season observations were made as to the percentage of flowering in the two treatments. As is indicated in the data of Table 2, although the repeated gibberellic acid treatments produced plants with an overall increase in height of 31 inches over the control plants, there was actually only a 10-inch increase in length of millable cane. Stalk weight, stalk diameter, number of nodes, length of internode, and yield in tons of cane per acre, were not significantly affected by the gibberellic acid treatments. The juice analyses showed no significant effects, nor was there any effect upon floral initiation.

Another experiment was carried out to determine the effect of date of application of gibberellic acid upon yield and juice quality of sugarcane. Starting in late August, additional plots of sugarcane plants which had not been treated previously were sprayed with 100 ppm gibberellic acid solution at 10-day intervals. Various plots received 5, 3, 2, and 1 such treatment prior to harvest data from this experiment are shown in Table 2, test B. In this test there was a significant effect in the overall height of the plants receiving five foliar applications of gibberellic acid. The plot which received a single treatment six days before harvest showed a significant increase in sucrose content of the juice. However, since this is a single observation the desirability of continued investigation of this phenomenon is indicated.

In view of the evidence above in which it appeared that foliar applications of gibberellic acid produced greater increases in height of sugarcane plants when environmental conditions were unfavorable for normal growth, two-month old plants, variety C.P. 44-101, were treated in the field during November. In this test two foliar applications of a 20 ppm gibberellic acid solution were made at an 11-day interval. The test terminated with a killing freeze 15 days after the second application. During this period the average maximum temperature was 68°F, and the average minimum temperature 51°F. The results of growth measurements taken at two intervals during this test are tabulated below:

Period	Growth in Inches	
	Treated	Control
November 6 to November 17	2.5	0.60
November 17 to December 2	2.1	0.80

Table 2. Effect of foliar sprays of Gibberellic acid solutions upon yield, juice quality, and flowering of sugarcane Variety C.P. 44-101 plant cane, Ashland Plantation, Houma, La. Harvested October 17, 1957.

Treatment	Height of plants	No. of joints	Length mill-able cane	Stalk diam.	Joint length	Brix	Sucr.	Purity	Tons per acre	Stalk weight	Flowering
	in.		in.	mm	in.	o	%			lbs.	%
TEST A											
G.A. Spray 10, 40, & 50 ppm 10-day intervals 4/19 to 10/4/57	133.8	15	94.2	22.0	6.3	15.31	11.90	77.72	29.89	2.28	76
Check	102.2	14	84.2	23.2	6.0	15.34	12.02	78.35	28.56	2.18	80
TEST B											
G.A. Spray - 100 ppm 1. 5 times * before harvest	112.9	13	86.8	24.5	6.7	14.69	11.17	76.03	30.90	2.35	62
G.A. Spray - 100 ppm 2. 3 times * before harvest	101.3	13	80.8	22.5	6.2	15.25	11.63	76.26	23.82	2.06	76
G.A. Spray - 100 ppm 3. 2 times * before harvest	98.3	14	88.7	24.0	6.0	14.89	11.65	78.24	29.90	2.23	85
G.A. Spray - 100 ppm 4. 1 time * before harvest	99.7	13	82.0	23.0	6.3	15.13	11.81	78.05	32.66	2.44	71
G.A. Spray - 100 ppm 5. 1 time * before harvest	-	14	83.9	24.0	6.3	16.23	13.04	80.34	27.26	2.24	74
Check	--	14	84.0	24.5	6.0	15.44	11.97	77.52	29.21	2.32	96

*1. Sprays applied 8/26, 9/5, 9/16, 9/25 and 10/4/57
2. Sprays applied 9/16, 9/25 and 10/4/57
3. Sprays applied 9/25 and 10/4/57
4. Spray applied 10/4/57
5. Spray applied 10/11/57

These results rather clearly indicate the pronounced effect of gibberellic acid in increasing the height of plants during periods in which cool temperatures greatly retard the growth of control plants. Another possibility suggested by such results is that gibberellic acid may in part replace the long day requirement for vegetative growth, as suggested by Lockhart (10). Previous workers (2, 11) have shown that gibberellic acid has replaced the long day requirement for flowering.

SUMMARY

Several experiments were performed to ascertain the effect of gibberellic acid on the growth of sugarcane. In greenhouse tests it was found that seed-piece treatments increased the height of plants 56 per cent for a period up to 23 days. After this period the rate of growth of treated plants appeared to level off while that of control plants continued at the same rate. At harvest 112 days after treatment there were no significant differences in height due to the gibberellic acid treatments. There were, however, significant differences in fresh weight of the plants at harvest, the untreated plants having a greater weight than the treated plants.

Repeated foliar application of a 10 ppm gibberellic acid solution applied to plants in the greenhouse produced plants which were 60 per cent taller and with a significantly greater fresh weight than control plants.

Experiments in the field with repeated foliar applications of

gibberellic acid solutions for a 6-month growth period produced plants 30 inches taller than control plants. However, harvest data indicated that such treatments produced only 10 inches greater length of millable stalks. The gibberellic acid treatments did not affect the ultimate yield of tons of sugarcane per acre, stalk weight or diameter, number of nodes or length of internodes, total solids, sucrose, or juice purity.

There was evidence from growth measurements taken throughout the growth period that gibberellic acid had a more pronounced effect upon height of plants when environmental conditions were unfavorable for normal vegetative growth. Growth measurements obtained during the extremely cool conditions of November showed that gibberellic acid treatments increased the height of plants three times that of controls.

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PRINCIPLES INVOLVED IN THE CHEMICAL CONTROL OF THE SUGAR CANE BORER

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The chemical control of the sugar cane borer by the use of an insecticide should be considered as an immediate control for an infestation at a cost less than the expected loss in cane. This means that the toxicity of an insecticide is only one of several factors to be taken into consideration in deciding on its use, and certain principles must be understood and weighed if effective and economical control over a period of years is to be obtained by the use of insecticides and other control measures.

We, as Sugar Cane Technologists, must concern ourselves with these technological principles of the borer problem in order to evaluate recommendations and apply them properly. Certain questions come to mind when drastic changes in recommendations for a sugarcane borer control program are made; namely,

1. With limited data, is it wise that the main sugar cane growing area of Louisiana be plunged into an organic insecticide program with its possible limitations and consequences, as shown by extensive data on sugar cane and programs with other crops?

2. Should ryania, with its specific uses and advantages, supported by many years of research data, field testing, and practical application, be dropped in favor of an "all out" program based on an organic insecticide, endrin?

3. What is the basis for such an untimely statement concerning the effectiveness of Trichogramma parasites, despite seven years of exhaustive research by Hinds, Spencer, Osterburger and others and upon which the recommendation for their use by the Louisiana State University has been based for 30 years?

4. What are the limiting factors in obtaining the most effective control of the sugar cane borer with insecticides?

The answers to these questions, based on an understanding of the principles associated with the problem, and representative data to support certain conclusions are given below.

I. Recommended Applications Should be Limited to Sugar Cane Acreage with a Borer Infestation Justifying the Monetary Expenditure.

Chemical control should be resorted to only where the proper checking of fields reveals the borer infestation in a general area to be sufficiently heavy to justify the cost. It should then be done right or not at all.

The sugar cane industry now enjoys the enviable position that many farms and also certain acreage on most farms do not have a severe borer infestation. This highly favorable position can be maintained only through the conservation of the natural enemies of the borer.

In a normal year, only about one-half of the cane acreage has a borer infestation which justifies the use of insecticides. With ryania, the material now being used by those in a chemical control program, the growers who are not dusting profit by those who are because of the fact that many of the heaviest infestations are controlled and spread to less severely infested fields is prevented. The general use of an organic insecticide, such as endrin, might cause a general increase in infestation on all places, eventually making it necessary that insecticides be used on all cane acreage or heavy borer losses be absorbed.

The Bunkie area is a good example of what the extensive use of organic insecticides may do. There was no borer problem in the area prior to the general use of organics on cotton. Today, the problem is many times greater in the Bunkie area than in the main part of the sugar cane area. The identical thing happened on Allendale Plantation, in West Baton Rouge Parish, in all cane acreage within a fifty acre radius of a hundred care block of cotton.

With an insecticide such as ryania, one or more applications may be applied, and then applications discontinued without fear of increasing borer infestation. Based on all available data this cannot be done with an organic insecticide.

II. An Early Season Program of Insecticidal Application

In an early season program of insecticidal control, the long period of time elapsing from the last application of poison to harvest time presents certain risks of reinfestation and thereby necessitates more complete treatment of infested areas. This fact increases the importance of the destruction of natural enemies of the borer by an organic insecticide.

A first generation control program was possible under conditions which existed at one time, when heavy borer infestations were more localized. In this case, success depends upon a near complete destruction over a wide area of the first generation, which actually does no damage measurable at harvest time, so that the population of succeeding generations, which do the damage will not be sufficiently heavy to cause injury. There are usually no joints on the plant at the time of the first generation so that protection of the plant is of no particular value.

The distinct hazard involved in this phase of control is the possibility of reinfestation by later generations. It is therefore necessary that a large part of the infested area be treated so as to lessen the likelihood of an influx of moths from adjoining untreated cane or corn.

In second generation control, protection is given to the lower five to seven joints of the cane plant so that benefits obtained are measurable at harvest time. Although injury from later generations are less likely to completely erase the benefits more effective control at harvest is dependent upon a sufficiently high kill of the second generation of borers so that there will be a minimum reinfestation. Actually, extending the period of protection to include second and third generations is highly advisable.

In future years, it may be advisable to go back to a first generation insecticide program, if borer infestations should again become more localized through the use of resistant varieties and higher kill of overwintering borers by more severe winter.

III. Young Borers Must be Killed Before they Enter the Plant and the Required Number of Applications be Applied.

The proper timing of chemical applications is very important for effective control since the degree of kill after the young borers enter the plant is rather insignificant.

A general recommendation on the number of applications to be used on a place cannot possibly take into account the actual need of a lesser or greater number of applications for a specific situation. It is generally understood that four applications are not actually necessary on much of the cane acreage in Louisiana and if applied, results only in added expense with no economic gain in degree of control. One, two, three, four or even more applications may be required depending upon the occurrence and development of the borer infestation in a particular field. In many instances only the first or second application is sufficient to bring an infestation under control. It is only with a material like ryania, which does not destroy natural enemies, that one can discontinue applications without fear of being eaten up by borer by harvest time.

So, under such conditions, an organic could not be substituted for ryania even though it was proven that it would result in a higher degree of control if four applications of each were applied. This does not take into account the probable consequences in future years. There is, therefore, a definite place for ryania in the chemical program even though the use of endrin or some other organic would be advisable.

IV. Extending the Control Period by Poisoning the Third Generation of Borers.

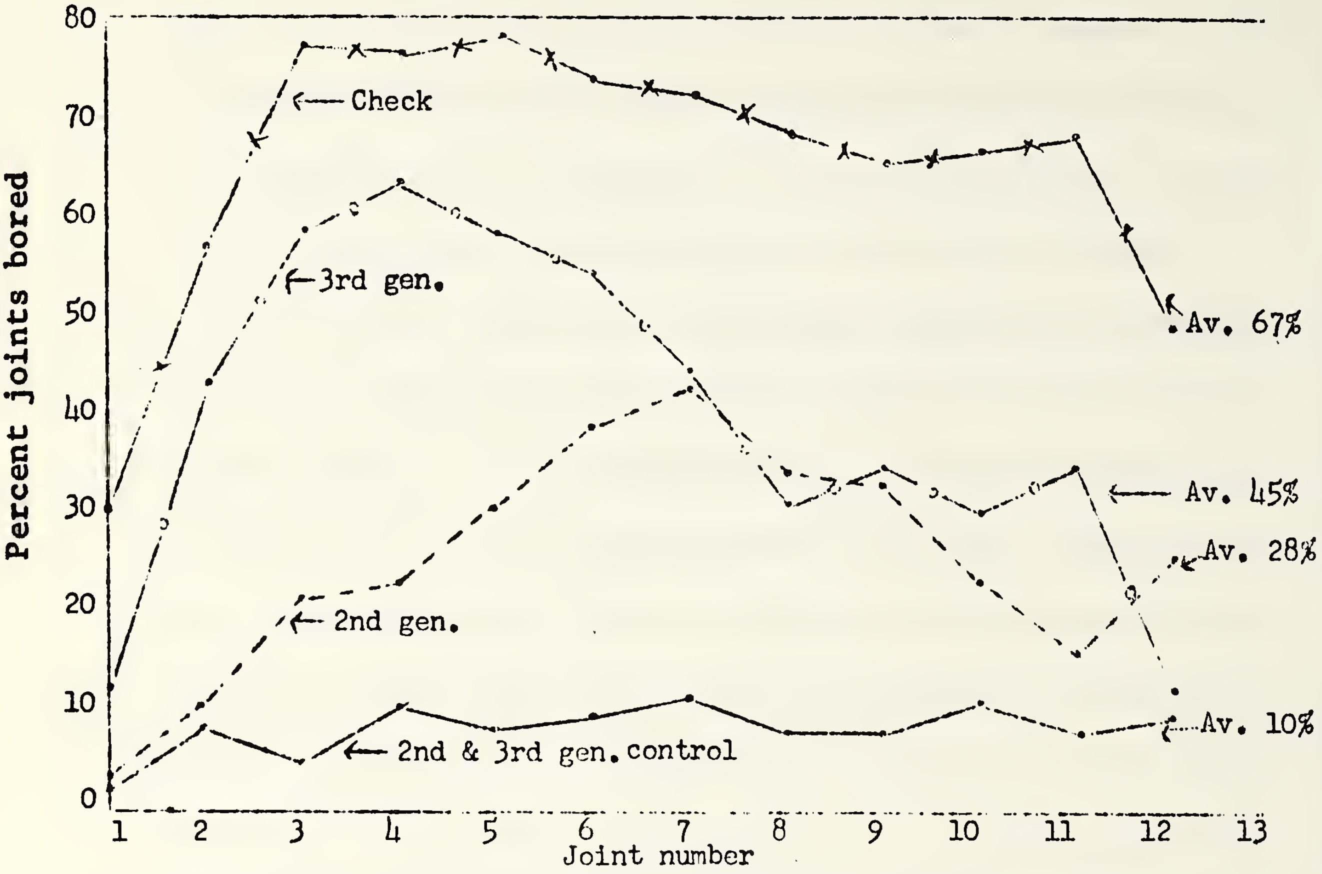
Control of second generation borers is not always sufficient in some fields of cane to produce the overall control desired. In most years the injury inflicted by third generation borers is of no real consequence, especially if Trichogramma parasitism has reached a high level. However, there are always certain fields in which extending the control period by treating for third generation infestations is highly desirable. This is especially true in stunted cane, which is subject to the same type of injury as that inflicted by the second generation to cane of normal growth.

On a farm where successful second generation control has been accomplished, except in stunted cane as described above, only one or two applications are usually required to protect localized areas from third generation attack. This may often be the answer to some dissatisfaction as to the ultimate control over an entire place. There are known instances where four unnecessary applications are made to control the second generation, whereas one or two on the third would have resulted in greater gains.

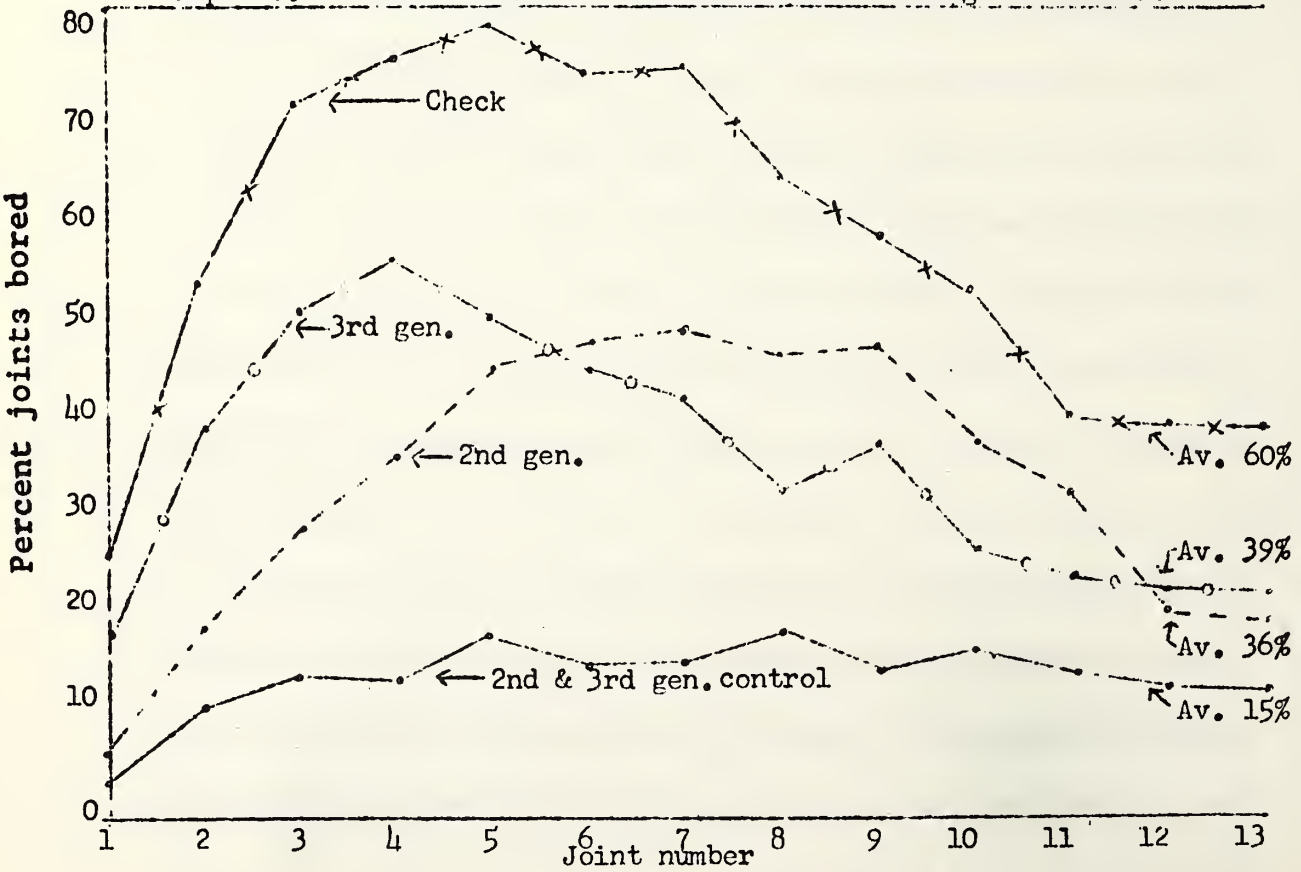
The results of two representative tests, one conducted on Georgia Plantation of South Coast Company and the other on Wilkinson's Poplar Grove Plantation, shows comparable gains that can be expected from second and third generation control, and the manner in which insecticidal control alters the location of borer infestation on the stalk. It is quite evident that the sugarcane plant is able to withstand a considerable degree of top joint infestation with comparatively little damage.

Graphs 1 and 2 depict the borer infestation as measured by the percentage of each joints bored in the summer and at harvest time, and Tables 1 and 2 give the increases in per cent sucrose and purity and in yields of cane and sugar from the control of the various generations of borers. An examination of the graphs gives a picture of the borer infestation by individual joints. The wide spread between infestation lines in the summer (graph (No. 1) are brought closer together by reinfestation and by third and fourth generation borer attack, thus showing a different picture in the harvest time graph. Graph 2 also shows how Trichogramma and other natural enemies reduce borer infestations as the season progresses, since there is a decided decrease in bored joints late in the season. The fact that second generation control protected the lower joints, allowed the plants to grow and produce millable stalks in spite of having 36 percent of the joints bored at harvest time. With only 3 percent difference in per cent joints bored at harvest, a gain of 6.67 tons and 1384 lbs. of sugar resulted from 2nd generation control as compared to 1.20 tons and 562 lbs. of sugar from the control of only the third generation, as shown in Table 1. The gains from controlling both generations is far from being what would be expected according to the differences in per cent joints bored. It is obvious from these data that the cane plant can withstand high infestations of borers in the top joints.

Graph No. 1 - Summer borer infestation by location on the stalk for various treatments - Georgia Plantation



Graph No. 2 - Harvesttime borer infestation - Georgia Plantation



The Poplar Grove test shows more significant gains from third generation control as evidenced by results in Table 2. It must be remembered that this represents what would be expected under the most severe conditions of late infestation and would not represent conditions which generally occur in practical field control.

Table 1. Control of various generations with ryania at Georgia Plantation.

	Generation controlled			
	2nd	3rd	2nd & 3rd	Check, no treatment
Borer infestation[1]	36	39	15	67
Cane/A increase	6.67	1.20	8.20	24.48
Sugar/A increase	1384	562	1734	3868
Approximate cost	$8.00	$9.00	$17.00	----

[1] Percent joints bored at harvest time.

Table 2. Control of various generations with ryania at Poplar Grove Plantation.

	Generation controlled				
	2nd	3rd	2nd & 3rd	Heavy appl.	Check, no treatment
Borer infestation[1]	22	34	17	10	58
Cane/A increase	6.21	2.37	7.47	8.39	25.43
Sugar/T increase	14	8	26	28	184
Sugar/A increase	1586	659	2230	2491	4679
Sucrose, percent	.89	.46	1.57	1.67	13.48
Purity, percent	.74	.69	2.96	2.58	79.99

[1] Percent joints bored at harvest time.

V. Destruction of Natural Enemies of the Sugar Cane Borer and Other Insects by Many Insecticides, Especially the Organics.

Ryania does not kill off the natural enemies of the borer or of the yellow sugar cane aphid. Very likely it does not affect the "natural enemies" of other insects, eliminating the chances of creating a new insect problem, whereas, organic insecticides do kill off natural enemies of the borer, especially the predators, and may account for a substantial build-up of borers by harvest time.

Increases in borer infestation have resulted from applications of DDT, benzene hexachloride, chlordane, parathion, and toxaphene in some instances. Apparently, this condition results from their injurious effect upon the "natural enemies" of the borer.

Toxicity of a material alone means very little in evaluating different insecticides for control of this insect. The effect of the insecticide upon the "natural enemy" and borer population relationship during the long period of time, about 3 to 5 months, from the date of the last application of dust to harvest time is very important. For example, in many tests, benzene hexachloride has given a fair kill of second generation borers as compared with cryolite, but by harvest time the infestations in the benzene hexachloride treated plots have exceeded that in the untreated checks by thirty per cent.

This injurious effect of some materials on the "natural enemy" population also has a bearing upon the toxicity of such material against the first generation or fall generations as compared to their toxicity to second generation borers (see Tables 3, 4, and 5). Against first generation borers, at which time natural enemies are less active, benzene hexachloride for instance resulted in a higher kill than did cryolite. But against second generation borers this poison has never done as well. The same is partially true for the other organics tried except for chlordane.

The importance of the post-treatment effects of various materials has also been shown in studies of the effectiveness of different concentrations of benzene hexachloride and toxaphene. From infestation counts at harvest time and final yield records, indications are that the lowest and the highest concentrations are more effective than the intermediate strengths. Perhaps the lower concentrations, although less toxic to the borer, were also less toxic to natural enemies and resulted in a more desirable balance of the two.

By altering the amount of chlordane from less than one pound to two pounds of technical material per acre an increase of as much as thirty percent in borer infestation from one pound or less to a very good kill of second generation borers with two pounds per acre, per application has resulted. However, the good kill does not persist until harvest time, and the infestation becomes increasingly worse as the season progresses. Of course, damage never reaches the high level resulting from the low dosages, but usually surpasses that of the untreated checks.

In an effort to find cheaper and perhaps more effective insecticides for control of the borer, most of the new and promising ones were tested as they became available over the past ten years. Results of numerous tests, in 1946, indicated that the organics had definite possibilities, so the program of work was expanded and accelerated the next two years to determine whether there was a place for these new chemicals and at what concentrations they would have to be used.

The results of 35 field tests in 1946, '47, and '48 proved conclusively that benzene hexachloride, toxaphene, parathion, and chlordane had no place in the sugar cane borer control program at that time. Although these materials in many cases showed a high toxicity to first generation and fall generations of borers (Tables 3 and 4), they often produced significant increase of the second generation (Table 5).

Table 3. First generation control, various insecticides.

Treatment	Live borers/A	Percent control
Cryolite, undiluted	113	79
Toxaphene, 10%	101	81
Ryania, 50%	181	67
BHC, 3%	52	90
Chlordane, 5%	504	7
Sodium flouride, 50%	93	83
Parathion, 5%	121	78
Check, no treatment	544	--

Table 4. Fall generation control, various insecticides (Summer plant cane).

Treatment	Live borers/A	Percent control
Cryolite, undiluted	40	90
Toxaphene, 10%	101	74
BHC, 3%	40	90
Ryania, 50%	12	97
Parathion, 5%	52	86
Sodium flouride, 50%	52	86
Cryolite-sulphur	52	86
Cryolite-parathion	73	81
Check, no treatment	383	--

Table 5. Second generation control, various insecticides.

	Borer infestation		Increase or decrease compared to check			
Treatment	Summer	Harvest	Sucrose	Cane/A	Sugar/T	Sugar/A
Cryolite, undiluted	9	18	2.05	2.33	31	1,120
Sod. Flouride, 50%	15	21	2.03	1.29	31	939
Ryania, 50%	5	13	2.54	4.42	40	1,731
Chlordane, 10%	42	64	-1.78	-6.65	-32	-1,476
BHC, 3%	32	55	-1.04	-4.88	-17	-1,007
Parathion, 5%	23	51	- .21	-2.87	- 4	- 491
Toxaphene, 10%	24	43	.06	-2.72	0	- 389
Cryolite-Tox.	21	48	- .47	-2.29	- 8	- 493
Check, no treatment	19	39	10.65	23.05	143	3,296

Apparently, this condition resulted from their injurious effect upon the natural enemies of the borer.

The results with toxaphene were promising enough in small plot tests and airplane strip tests that, in 1947, several comparisons of cryolite and toxaphene were made in block treatments of 5 to 35 acres. On practially every farm, toxaphene gave only slightly less control than cryolite in the summer, but accounted for a heavy build-up of borers by harvest time, as noted in Table 5. It was then dropped from the program, but other new materials were tested as they became available.

Table 5. Second generation control in block airplane treatment - Germania Plantation.

Treatment	Percent Joints Bored	
	Summer	Harvest
Cryolite	17	22
BHC, 3%	18	43
Toxaphene, 10%	19	37
Check, no treatment	23	29

Endrin was brought into the research program in 1951 as compound 269, and tested as a dust against second generation borers and fall generations in early planted cane along with several other new materials. Table 6 shows that compound 269 was only slightly effective. Ryania gave an increase of 769 pounds of sugar per acre as compared to 142 from the use of compound 269.

Against fall generations of borers, compound 269 was much less effective than ryania, resulting in 49 percent control as compared to 97 percent with ryania (Table 7).

Table 6. Control of second generation borers with new materials - 1951.

Treatment	Borer infestation Joints bored Summer	 Harvest	Increase or decrease over check Cane/A	 Sugar/T	 Sugar/A
	Percent	Percent	Tons	Pounds	Pounds
Cryolite	12	26	3.44	7	671
Ryania	4	17	3.89	9	769
Systox spray	21	38	1.49	3	300
Pestox spray	19	35	1.77	9	432
EPN	7	43	.25	0	53
Rothane	12	45	1.40	-5	136
Compound 269	11	35	- .88	17	142
Compound 711	7	28	2.01	3	363
Check, no treatment	16	38	--	-	---

Table 7. Control of fall generation of borers with new materials - 1951.

Treatment	Live borers per acre	Control
	Number	Percent
Cryolite	61	94
Ryania	30	97
Ryania spray	18	98
Compound 711	393	59
Compound 269	484	49
Dieldrin	230	76
Aldrin	472	51
Check, no treatment	956	--

Endrin was brought back into the research program in 1955 by the author, when it was compared with ryania, aldrin, dieldrin, toxaphene, and heptachlor in a test at Centerville. A discussion of the results was presented in the 1955 report of "Sugarcane Insect Investigations" by Dugas, Concienne and Sibley, under the heading, "Value of organic insecticides for borer control for possible use in the Bunkie area."

It was stated in this report that the possibilities of the economic use of organic materials on sugar cane in the Bunkie area, where these insecticides are applied extensively in cotton, has been a question for some time, and that the objective of the test was to re-evaluate some of the organic insecticides, with the idea of using the more promising ones in tests at Bunkie in 1956.

In this test, endrin and toxaphene gave excellent control, especially the eight applications, Table 8. Savings in cane yields of 6.18 and 8.12 tons, and in sugar per acre of 1674 and 1766 pounds, resulted from 8 applications of endrin and toxaphene, respectively. It further stated that these two materials were to be compared with ryania as dusts and as granules in the Bunkie area in 1956.

The test that followed was planned by the author before taking a leave of absence in March of 1956, and was conducted by Mr. Concienne. Under the conditions of extensive use of organics on cotton and extremely high borer infestation the endrin dust and granules were equally effective, Table 9. The results of this one test are no indication of the comparative effectiveness of ryania and endrin over the entire cane belt or even in the Bunkie area. This is the only test to date covering the full growing season which compares ryania and endrin granules.

Results of the only full year test in 1957 including granular endrin are shown in Table 10. Ryania was excluded from the treatments. It is evident that the endrin dust failed and resulted in about a 2 ton decrease in yield. Endrin granules showed up to be good but so did toxaphene granules; however there was no correlation between per cent control and yield of cane with most of the treatments. This is a common occurrence where plots consists of full cuts and other factors effect yields.

In a test at Franklin, in 1957, only endrin dust was used. Table 11 shows that there was no significant differences in the percent control obtained from any of the treatments. The whole test area was heavily bored, quite similar to what has happened in many previous tests in which organics were used.

This review of the available data points out that there is limited results from strip airplane tests with endrin granular material in the Bunkie area, but none for the main growing area.

More Recent Experimental Data with Endrin

Table 8. Second and third generation control at Centerville, 1955.

Treatment	Borer Infestation		Increase or decrease compared to check		
	Summer	Harvest	Cane/A	Sugar/T	Sugar/A
Ryania, 40%	24	34	5.02	19	1181
Ryania, 100%	27	46	3.89	2	574
Aldrin, 2%	34	56	1.37	3	254
Dieldrin, 2%	35	62	1.30	12	508
Endrin, 2%	11	27	6.18	30	1674
Toxaphene, 20%	15	20	8.12	23	1766
Heptachlor, 5%	34	52	3.19	12	770
Check	48	62	----	--	----

Table 9. Second and third generation control at Bunkie, 1956

Treatment	Percent control	Lbs. sugar	Net Profit
Ryania, 40%	69	1085	$33.57
Toxaphene, 20% dust	78	998	$34.32
Endrin 2%, dust	97	1847	$69.27
Endrin 2%, gran.	98	2050	$76.88

Table 10. Second and third generation control at Bunkie, 1957.

Insecticide treatment	Percent control	Tons of cane per acre
Endrin 2% dust biweekly	27	25.72
Endrin 2% dust weekly	50	29.90
Endrin 2% gran biweekly	89	35.96
Endrin 2% gran. weekly	93	35.55
Toxaphene 20% dust biweekly	45	28.83
Toxaphene 20% dust weekly	73	31.28
Toxaphene 20% gran biweekly	73	30.97
Toxaphene 20% gran weekly	86	28.12
Check	-	27.52

Table 11. Second generation control at Franklin, 1957

Insecticide treatment	Percent Control
Ryania 40% biweekly	45
Ryania 40% weekly	43
Ryania 100% biweekly	58
Ryania 100% weekly	46
Endrin 2% biweekly	54
Endrin 2% weekly	66
Toxaphene 20% biweekly	40
Toxaphene 20% weekly	52

VI. Biological Control or Use of Parasites, and Natural Control by Enemies Possible Because of Insecticides Being Used.

There is much evidence to show that the extensive application of an organic insecticide would probably destroy natural parasite and predator population, thereby eliminating the likelihood that such natural enemies would have a chance to build-up to where they were able to effect a control of the borer, as is the case on a large part of the cane acreage today. Perhaps, the effect on Trichogramma would not be as far reaching as that on the predators. Ryania has never shown any destructive qualities on either Trichogramma or other natural enemies.

The parasite recommendation from Louisiana State University has been based on seven years of extensive research by Hinds, Spencer, Osterburger, Stracener and others (see graph 3 and Table 12), which proved conclusively that artificial release of Trichogramma resulted in an increase in sugar per ton of cane. The only work not in agreement with these findings is that of Jaynes and others on the U.S.D.A., the results of which have been materially effected by their use of a strain or species of Trichogramma that attacks the eggs of fruit tree insects rather than those of insects of row crops such as sugar cane.

No recent work has been done which disproves the effectiveness of artificial releases of Trichogramma, whereas, county agents, growers, research workers and others have observed countless instances of substantial benefits from parasite release. There are growers using parasites who will not use insecticides. Some of them should, since it is

Graph 3 - Trichogramma parasitism progress of borer eggs in colonized, adjacent & check fields.
South Louisiana

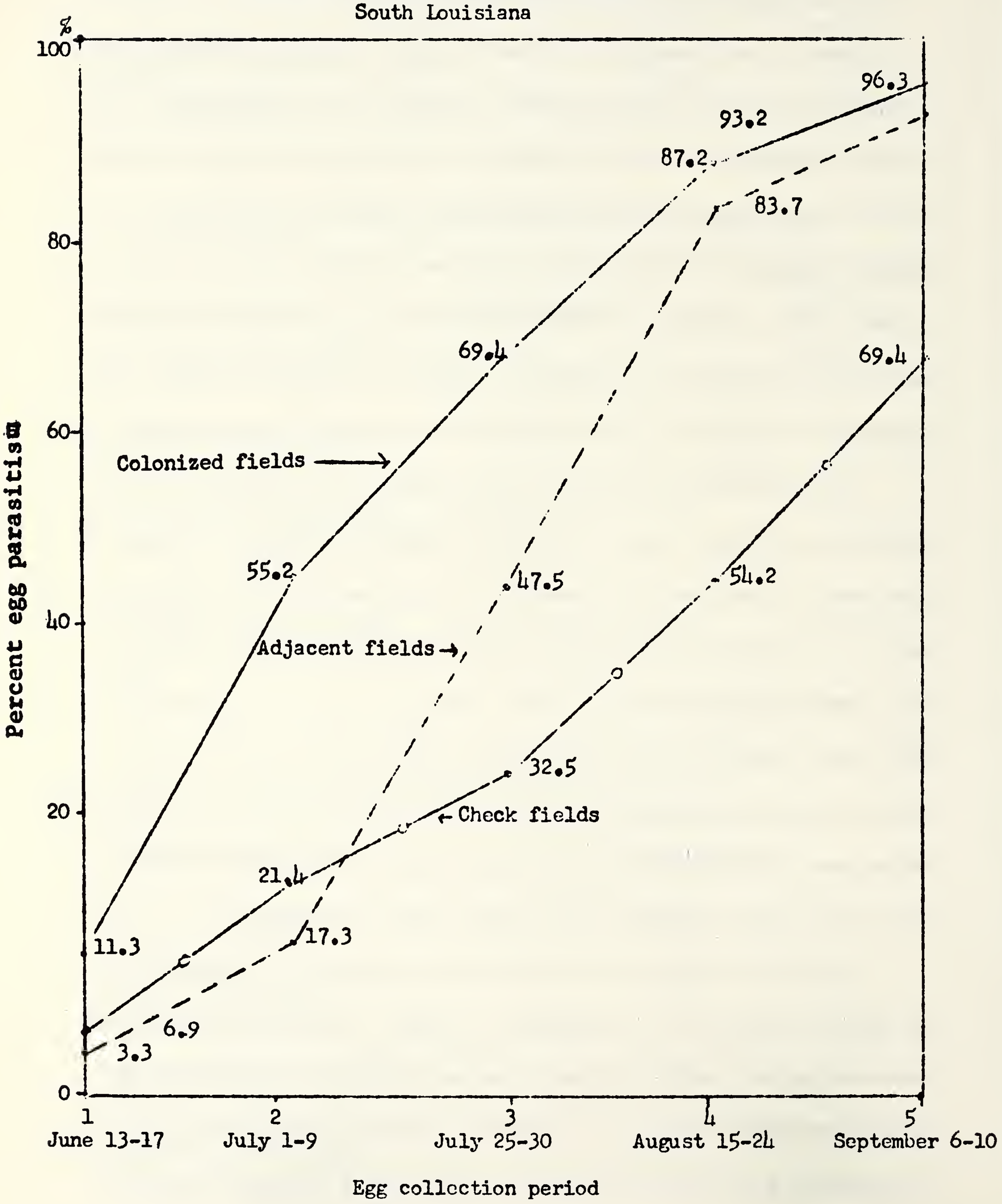


Table 12. Decrease in borer infestation and increase in sugar as shown by Hinds' extensive data on Trichogramma releases.

Field Treatment	Percent Parasitism July	Percent Parasitism Aug.	Percent Stalks bored	Percent Joints bored	Lbs. Sugar per ton
Colonized	64	87	64	14	178[1]
Adjacent	48	84	59	12	157
Check	24	58	93	32	

[1] Average of colonized and adjacent fields.

known that parasites cannot do a satisfactory job alone if the borer infestation justifies the use of insecticides.

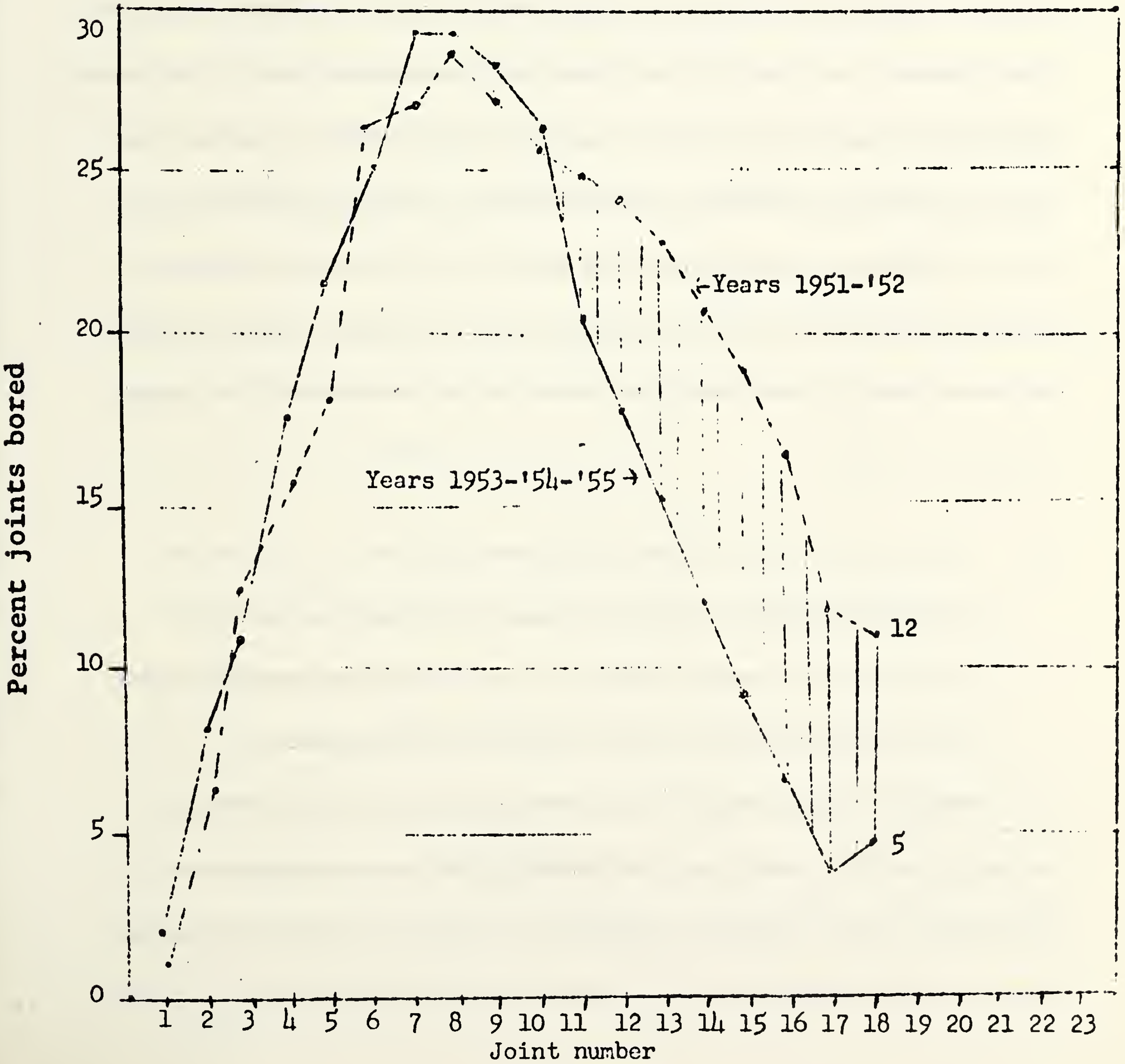
From 1953 thru 1956, there was a noticeable decrease in the percentage of joints bored on the cane stalk beyond the tenth joint over most of the cane area. An analysis of borer losses survey data for two years prior to the mass releasing of Trichogramma and for three years during which large scale releases were made is shown in graph 4. This is substantiated by the spread between the two lines and if due principally to artificial parasite releases would mean not only a lowering of borer losses but an aid in reducing numbers of overwintering borers.

In Barbados, BWI, successful control of the borer has been obtained from Trichogramma parasite releases on a practical field basis for more than thirty years. The use of these parasites has also been proved successful in India.

VII. Savings in Cane and Sugar Yield Are Proportional to Level of Borer Infestation.

The level of borer infestation on thousands of acres of cane each year is too low to justify the cost of insecticides. The greatest gains or returns from expenditures for dusting are obtained where the borer infestation is high, although there may be more evidence of borers at harvest time in such treated fields than in fields treated for a light infestation. So in order to be assured of greater returns from the dollar spent on chemical control of the borer it is possible to set a

Graph 4 - Average percentage of joints bored 2 yrs. prior to and during 3 yrs. of parasite release on same places.



higher level of infestation at which fields are treated. This has been done on some of the larger groups of plantations with great success and at a substantial savings in cost of the completed program.

It has already been noted that the percentage of joints bored at harvest time in a dusted field is not a true measure of losses, since the dusting results in a change in location of the bored joints, moving the infestation to the upper joints which results in significantly less injury. This is an important factor to remember in interpreting results from dusting. Protection of the cane plant from borer injury to the lower joints at the most critical time, usually in June and July, allows the plant to produce a millable stalk regardless of the later reinfestation in the top joints. Protection of the lower joints in this way means that the cane plant can withstand terrific borer attack. This should be remembered in evaluating how much can be economically spent on chemical control.

VIII. Supervisory control offers good possibilities for eliminating unnecessary dust applications and increasing the degree of control through proper timing, and extending the control period over a longer period of time without increasing cost.

Whether it be through a commercial source or by someone on the farm, weekly supervisory control to tailor recommendations to individual areas of a farm or plantation, rather than the use of broad general recommendations which cannot consider local factors, is an excellent way to realize savings from significantly better control at lower cost.

The timing of applications is improved considerably, and applications are not started in any areas on any place until borer development justifies it. Better use is thereby made of all applications. Just as important is the fact that unnecessary applications are eliminated and the number of applications to be used are governed by actual weekly conditions. Generally speaking, the difficulty of having to decide upon entire chemical programs prior to starting applications is eliminated in favor of weekly recommendations based upon current borer conditions.

Another important advantage is that the control period may be extended to cover both the second and third generations with no extra cost and usually at a savings. For particularly troublesome areas requiring special attention, the dosage rates can be increased to reduce an abnormal high infestation more rapidly.

CONCLUSIONS

1. After considering the principles involved in the chemical control of the sugar cane borer we must conclude that at this time the main sugar cane growing area of Louisiana should not be plunged into an organic insecticide program with its possible limitations and consequences, especially with the limited amount of data now available on endrin. With further research and practical field testing, a place may be found for the material.

In the Bunkie area, where organic insecticides are used extensively on cotton and the borer infestation is so heavy and widespread, there appears to be a definite place for endrin, and it should be tried on a large scale, but watched closely. It was brought into the research program for this purpose, with the idea that it may do a better job and save on number of applications under the existing conditions.

2. Ryania is a safe and effective insecticide having specific uses and advantages for practical control of the borer which no organic is known to have, and it would be a serious loss to the cane industry if it should be dropped in favor of an "all out" program based on an organic material or its supply cut off, before a better material similar in nature is found and developed. Its use is supported by more than fifteen years of research, field testing and practical field application.

3. There is no recent data to prove that Trichogramma parasites are any less effective than they were at the time that the University accepted an appropriation to develop laboratories for mass rearing to establish an available supply for the growers. At that time the recommendation based on seven years of extensive research by Hinds, Spencer, Osterberger, and others, had stood for thirty years. Further, there has been nothing done since the business of rearing of the parasites was transferred from the University to a commercial source to support the recent statement regarding their effectiveness.

4. Although the ryania program has been quite successful there are associated with its use, as with any insecticide, certain limiting

factors which effect degree of success; such as, improper timing; improper use of insecticidal applications; poor plane application of the insecticide; limited control period; improper selection of fields requiring treatment; abnormal infestations; unfavorable weather conditions; and perhaps foremost in importance is limited participation in the program.

THE TWO ROW CANE HARVESTER

B. C. Thompson

During the 1957 cane harvest season there was a Committee appointed composed of processors and growers to study the method of harvesting and handling sugar cane. There was a feeling that the whole method should be reviewed as nothing particularly new had been added to the method of harvesting, loading and hauling over the past seven or eight years. There had been, of course, constant improvements in the equipment, but each year that went by there had been an increase in tonnage of cane per acre due to improved methods in planting, fertilization and cultivation which meant that harvesting equipment had to meet these changing conditions; and did.

It had become standard practice that there was one Harvester and one Loader used on a basis of ten to twelve acres of cane being harvested per day.

The newer varieties of cane are giving much heavier tonnage per acre and much of the heavy producing cane had a bad tendency to lodge, which made harvesting more difficult and yet it was the best cane from both tonnage and sucrose. During the three past harvest seasons we have had heavy winds that have affected some areas and have made harvesting much more difficult, but the Harvester manufacturers have done everything in their power to improve their machines to take care of this down cane, and have met it in a more or less satisfactory manner, but in harvesting badly lodged and down cane the acreage harvested per day has been greatly reduced.

Under favorable conditions a Harvester that would harvest ten to twelve acres per day, when it gets into these recumbent cane fields where they have been badly disarranged by excessive rains and winds, the acreage harvested has been reduced practically in half. That has meant that a cane grower in order to meet his daily quota at the mill, has had all kinds of scheming to do it, either to have stand-by Harvesters to supplement his regular operations or to get rent Harvesters or do whatever could be done to meet the situation.

The first mechanical machine that was ever introduced into the sugar belt is what was known as a Windrow Machine. These machines were built with twelve foot tread and would cut two rows at a time in passing through the fields. The Thomson Machinery Company in the years 1938, 1939 and 1940 produced some thirty-eight 2-Row Harvesters for harvesting cane. At that time there was no attempt made to put cane in heaprow, it was simply a case of cutting it and letting it fall back on top of the row.

The principal objection to this 2-Row Harvester that had twelve foot tread in those days was because we had narrow headlands, narrow bridges and narrow gates so the 2-Row machine was abandoned and the single row was built in 1941. The single row machine was actually the 2-Row machine split in half.

In trying to cooperate with the Committees and to review that part of the program that would be the duty of the Harvester manufacturers and to assure enough harvesting each day to meet the quota regardless of field conditions the Thomson Machinery Company built in 1957 a 2-Row Harvester. Due to labor conditions and the fact that we were trying to get this Harvester in the field during the harvest season of 1957 at the latest, we did get this machine finished in time to give it a fair try-out in the very last stages of the 1957 crop--and it is promising.

We feel that a 2-Row Harvester will harvest eighty per cent more cane per day than a single row which means that under favorable conditions, by operating a full day you will be able to maintain your quota.

The cost of the 2-Row Harvester will be about one-third more apparently than the cost of the single row. We expect to show you some moving pictures of this 2-Row Harvester either before or after submitting this paper on this subject and we would like to add also that we devoted considerable attention to Cane Pilers in connection with Cane Loaders and we feel like, unquestionably, our new Scroll Piler will lift cane and roll it into a bundle for picking up with the Loader and do so with less dirt or mud than anything that has ever been offered before.

A NEW CROP ROTATION SYSTEM

F. Evans Farwell

Reference is made to the article presented before this Association on March 1, 1955. A discussion of some of the experiments being conducted was included, and this paper concluded as follows: "It is hoped that newer and better experiments than those listed above can be started soon, with ideas and results pooled for the benefit of our industry. Certainly, if we can find economical ways to improve the physical condition of our soils, our efforts will not be in vain."

It is interesting at this point to look back at some of the various "rest crops" used over the past years in connection with sugarcane.

In the early days, straight corn was grown for mule feed, the residue being plowed down and the land planted in cane the same year. Then a progressive step was taken: cow peas and beans were interplanted with the corn. This improved the soil and worked well until the unfortunate spread of Johnson grass during the first World War. Interplanted corn and beans resulted in an ideal environment for the growth of seeding of Johnson grass. After 1947, where Johnson grass was a menace, corn and beans were planted separately. In many cases the corn was not followed by cane. However, in the case of beans, they were turned under in the early summer and the land fallow plowed until cane was planted in September.

We normally do not think of any part of the grinding season as a "slack period" but during late October and early November, the weather is generally good, with the result that the mills are over-supplied with cane and strictly enforce delivery quotas, with the result that during this period some tractors and labor are available to plow-out stubbles that are not to be kept for the following year.

A later evaluation of fallow plowing demonstrated that best results were obtained when the stubbles and rhizomes were destroyed in the fall.

Shortly after adopting fallow plowing as a regular method of controlling Johnson grass, it became apparent that eventually some means would have to be found whereby humus could be returned to the soil. During the past 16 years an intensive search has been under way to find the ideal crop rotation system where Johnson grass could be controlled without destroying the humus content of the soil.

What was sought?

A crop:

1. That would have a heavy growth which would shade out or smother weeds.
2. That would provide its own nitrogen to hasten its decomposition after being turned under.
3. That could be plowed-down in sufficient quantity to add humus to the soil.
4. That could be planted in a "slack period."
5. That would have sufficient growth in the winter to help arrest soil erosion during the rains of January, February, and March.
6. That would not produce troublesome seeds for the following year.
7. That would continue to grow in the hot weather of May and June, or until the regular cane crop was laid-by; so that it would not need attention from the agricultural equipment and labor until the cane crop had been sprayed, fertilized, cultivated, and laid-by.

After three years of careful experimentation, we find that the following clovers meet the above specifications:

> FLORANNA annual white sweet clover (Melilotus alba var. annua Coe)
>
> HUBAM biennial white sweet clover (Melilotus alba Desr.)
>
> Floranna is reputed to make an earlier and more luxuriant growth than Hubam. However, we have not been able to find any measurable difference between these two clovers.

As an unexpected "bonus" these clovers bring large numbers of birds, which are believed to help control insect, bugs, beetles, etc.

Some of the crops that we tried to fit into the rotation system were: Oats, Barley, Lupine, Kudzu, Rye, Vetches, Crotalaria, Singletary Peas, Hemp, Heavy Corn, Sorghum, Soy Beans, Velvet Beans, Cow Peas, Lespedeza, and, of course, Melilotus Indica. For one reason or another, these crops did not meet the specifications. Melilotus Indica came closest, but it showed erratic growth, which possibly was due to disease as much, if not more than, to soil conditions. The main point where Melilotus Indica would not meet the specifications was that it would die out the first hot weather, with the result that the Johnson grass would come through it, and agricultural equipment would have to be taken out of cane to plow the land.

In our case, Melilotus Alba was tried on a small scale in 1956. The results looked so good that we put it in on a full scale basis on five plantations in 1957. The same procedure was followed for the current year. The very bad weather last fall prevented the full planting at that time, and some of the seed was not planted until February and early March this year. In spite of an unusually bad season, the alba clover has again come up to expectations.

Where Johnson grass was a menace, it is noticeable that less appears where alba clover was planted and the land fallow plowed in the summer than where the stubble was plowed out in the fall and the land fallow plowed all spring and summer. Similar tests indicate better conditioned soil.

It is important that the seed be treated with inoculant before planting. At present it appears that 12 to 15# of seed per acre are the right amount, though as we gain experience, we may find that a lesser amount can be used. Good results have been secured where the old stubble was simply disced before planting the alba. However, where possible, it is best for the stubble to be broken out and the land plowed and disced before planting the alba clover.

For the second year, it is again planned to plant these clovers on the ditch banks of lands that are planted in cane in August or September, leaving the clover to smother weeds the following spring and early summer.

Where land is to be kept out of cane for two years - a two year fallow-alba clover appears ideal as a cover crop, as it can be handled with a minimum of labor. If allowed to go to seed the first year, the land can be fallow plowed four or five times during the summer and the clover, having reseeded itself, will require no attention until the following June.

PHYSICAL PROPERTIES OF SOILS IN THE SUGARCANE AREA OF LOUISIANA

G. W. Shuker and W. H. Patrick, Jr.

The soils on which sugarcane is grown in Louisiana are of alluvial origin. Although laid down at different times, the Pleistocene terrace soils west of the Atchafalaya basin, the Mississippi terrace soils in St. Mary and Iberia Parishes, and the soils of the present Mississippi River floodplain are all formed largely on sediments deposited by the Ohio and Mississippi Rivers (1). The soils on the oldest of the above formations, the Pleistocene terrace, have been weathering in place much longer than the other soils of the sugarcane area and therefore differ markedly from the more recent soils in physical and chemical characteristics.

Soils of the Mississippi terrace are intermediate in age between the Pleistocene terrace soils and those on the modern floodplain of the Mississippi River. They were formed from sediments deposited by the Mississippi River and its distributaries when the Mississippi flowed through the Teche-Mississippi channel. The Mississippi left the channel that is now occupied part of its length by Bayou Teche around 2000 years ago (1), and the soils on the natural levees of the Teche-Mississippi and its two main distributaries, Bayou Sale and Bayou Cypremort, have been developing since that time without new additions of alluvium.

Soils on the present day Mississippi River floodplain or first bottom are from alluvial sediments that are continuing to be deposited except where overflows of the river are prevented by artificial levees. The soils formed from this material are consequently immature, with little profile development.

With both the Mississippi terrace soils and the soils of the present floodplain, physical properties of texture, structure, and drainage are more important than chemical properties in determining the soil's suitability for sugarcane production. The soils best suited for sugarcane are the medium-textured soils that occur on the natural levees of the streams. These soils have moderate surface and subsurface drainage due to their relief and texture. While not having the nutrient supplying capacity of heavier soils farther from the natural levees, their better structure and aeration make them superior to the heavier, poorer drained soils for sugarcane production.

The pattern of medium or coarse textured soils on the natural levees grading into finer textured soils at lower elevations is a reflection of the process by which an overflowing stream deposits its suspended load. The coarse material is deposited near the stream banks while the finer clays which settle more slowly are deposited in the back swamps. The higher elevation of the natural levee enables it to drain onto the lower-lying area toward the backswamp.

Little data is available on the physical properties of the soils in the sugarcane area. O'Neal and Breaux (3) conducted a reconnaissance survey of the soils of the area around 1930. They made general observations of the texture, color and water movement in soil profiles and made specific measurements of surface and subsoil pH values. Scarsbrook et al. (5) measures depth to the plow pan and bulk densities of both surface soil and plow pan of several soils in the sugarcane area. Included in their study were members of the Baldwin, Iberia, Lintonia, Oliver and Mhoon series. The plow pans of these soils were considerably higher in bulk density than the surface soil.

Lund (2) studied the physical properties of 15 soil series of alluvial origin in Louisiana, several of which came from the sugarcane area. He found that these soils had high available moisture holding capacities, attributable for the most part to their high silt contents. He measured no association between clay content and available moisture, although the percentage clay was very closely associated with the wilting point. For the group of soils as a whole, permeability was very low. A highly significant correlation coefficient between permeability and the percentage of large pores (those drained at tensions lower than 60 cm. water) emphasized the importance of structure in maintaining large openings through these fine-textured soils.

The purposes of this present paper are to summarize a study made by the authors of the physical properties of several fairly representative soils of the sugarcane growing area (6), and to present the results of experiments in which the effects of various cultural treatments on soil structure were measured.

Richland Silt Loam

The Richland soils have moderately slow internal drainage. They are intermediate in drainage conditions between the Lintonia series and the Oliver series. These soils have fairly well developed profiles with considerable leaching of bases.

The relative percentages of soil solids, noncapillary or large pores, and capillary pores throughout the profile are shown in Figure 1. The marked increase in the solid fraction at the 7 to 15 inch depth is due to a compact plow pan. Noncapillary porosity is at a minimum in this zone. The distribution of clay throughout the profile, Figure 2, indicates the eluviation of clay from the A horizon into the B horizon. The weathering indicated by this distribution of clay has also resulted in an acid reaction throughout the profile. The moisture release curves of three horizons of this soil are shown in Figure 3. A slight increase in tension in the 0 to 1 atmosphere range results in the removal of a large fraction of the soil water. Little water is available to the plant from either the surface soil or subsoil at tensions higher than 3 atmospheres.

Cypremort Silt Loam

The Cypremort soils occur largely on the crest of the natural levees of the Teche-Mississippi River and its distributaries. These soils are moderately well drained and most areas are in row crop production because of favorable texture, relief and internal drainage.

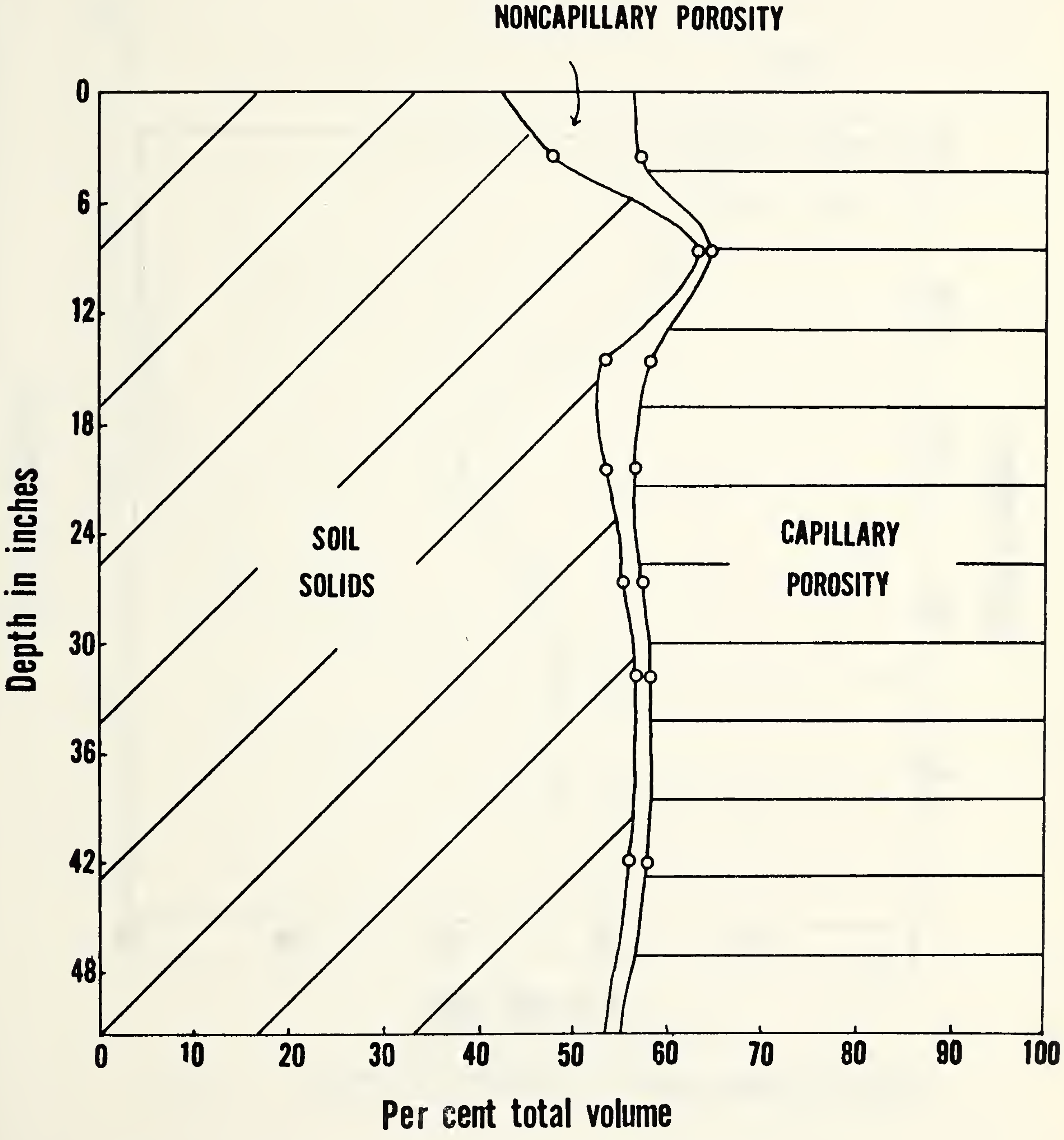


Figure 1. Volume distribution in a Richland silt loam.

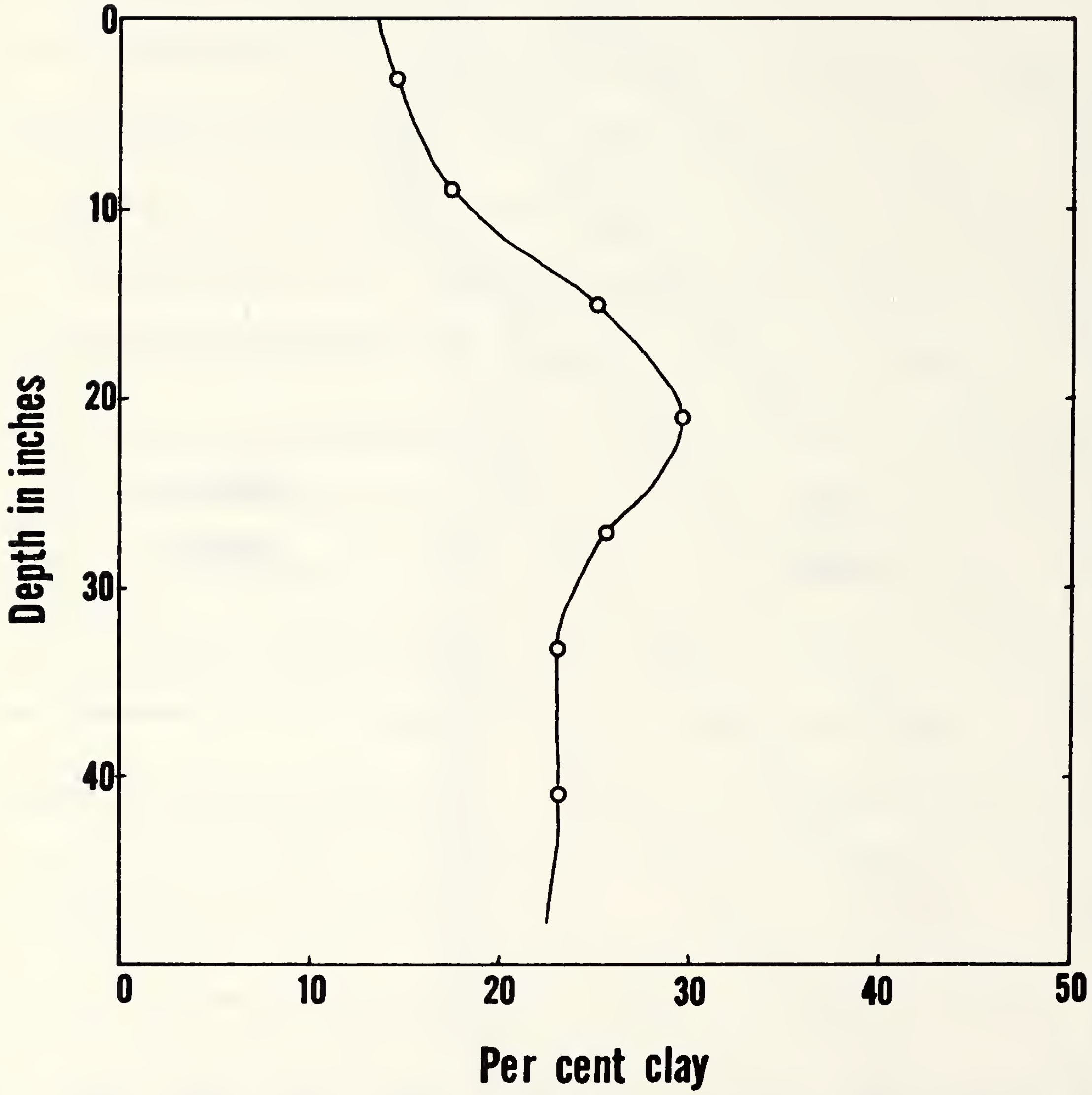


Figure 2. Clay content of a Richland silt loam.

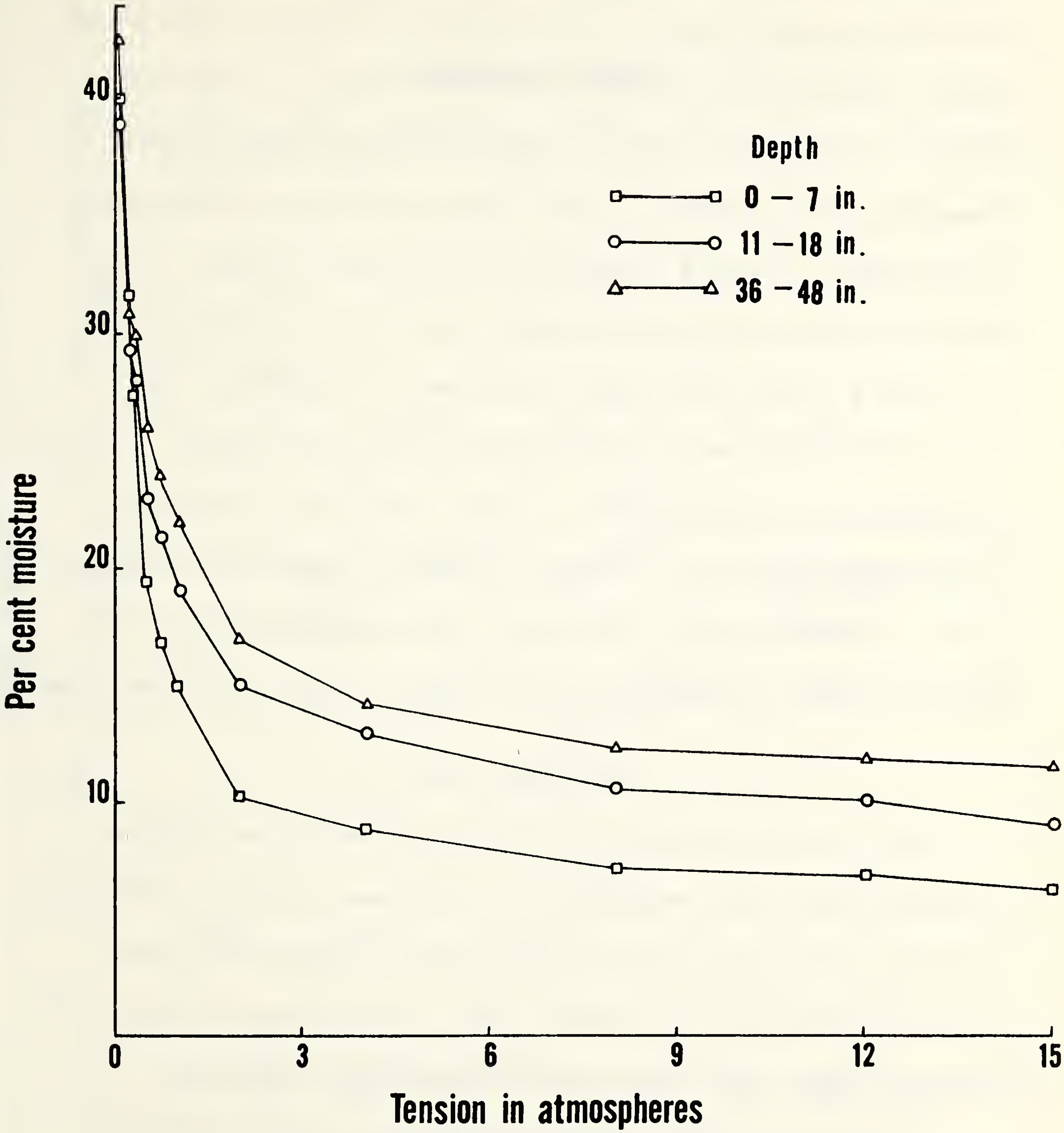


Figure 3. Moisture release curves for a Richland silt loam.

The relative volumes of soil solids, large pores and capillary pores of the Cypremort silt loam selected for this study, Figure 4, show a fairly porous, well-drained soil down to a depth of 33 inches. At the location sampled, a layer of silty clay was encountered at this depth. This is especially evident in Figure 5, which shows the clay distribution throughout the profile. This soil normally has an accumulation of clay in the B horizon as a result of profile development, but the increase in clay content of the B horizon was not very pronounced in the profile studied. Moisture release curves for this soil show that the water holding capacities of the surface horizons are low, Figure 6, but that the clay underlying these horizons is capable of retaining considerable moisture. In fact, at the wilting point of this layer, approximately one-third of the total soil volume is occupied by water. Aeration in this layer is very poor.

Baldwin Silt Loam

The soils of the Baldwin series are closely associated with the Cypremort soils on the natural levees along Bayous Teche, Sale, and Cypremort. They occur at lower elevation and are composed of finer-textured material than the Cypremort soils. For this reason, both surface drainage and internal drainage are somewhat restricted.

The Baldwin silt loam profile studied has a favorable distribution of pore space between large pores and capillary pores in the surface horizon, Figure 7, but the low noncapillary porosity of the subsoil emphasizes its slow internal drainage. There is a considerable

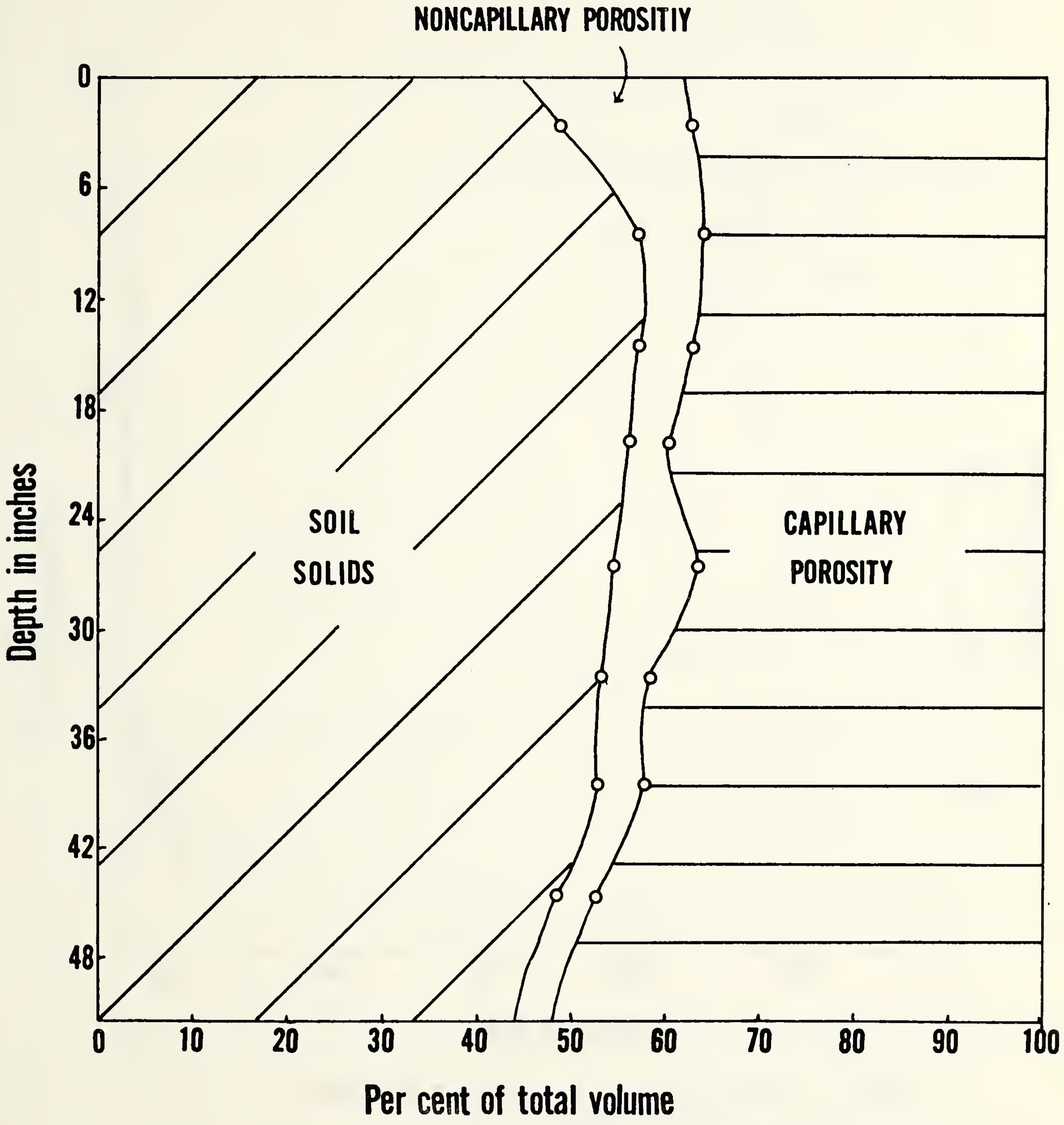


Figure 4. Volume distribution in a Cypremort silt loam.

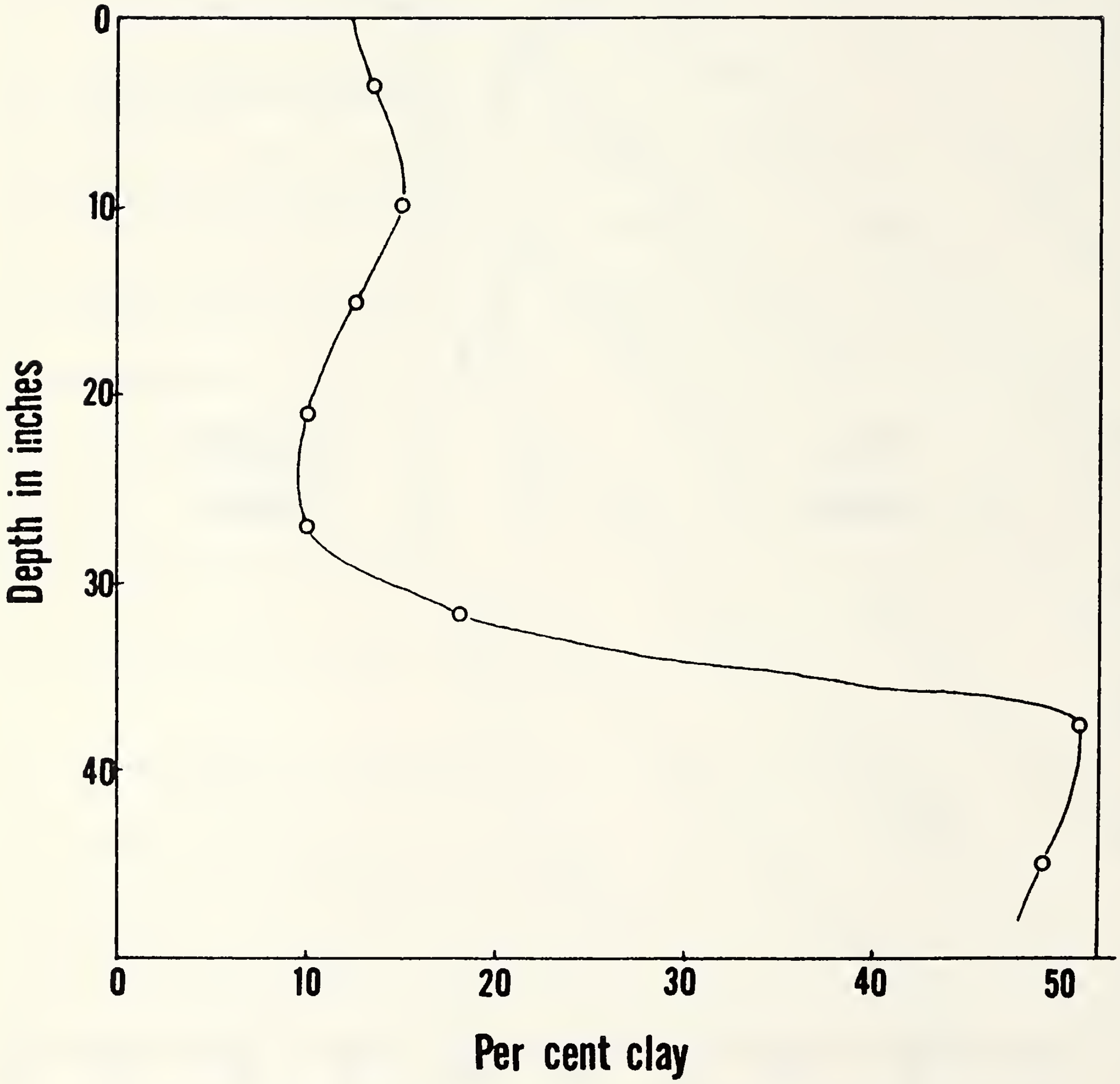


Figure 5. Clay content of a Cypremort silt loam.

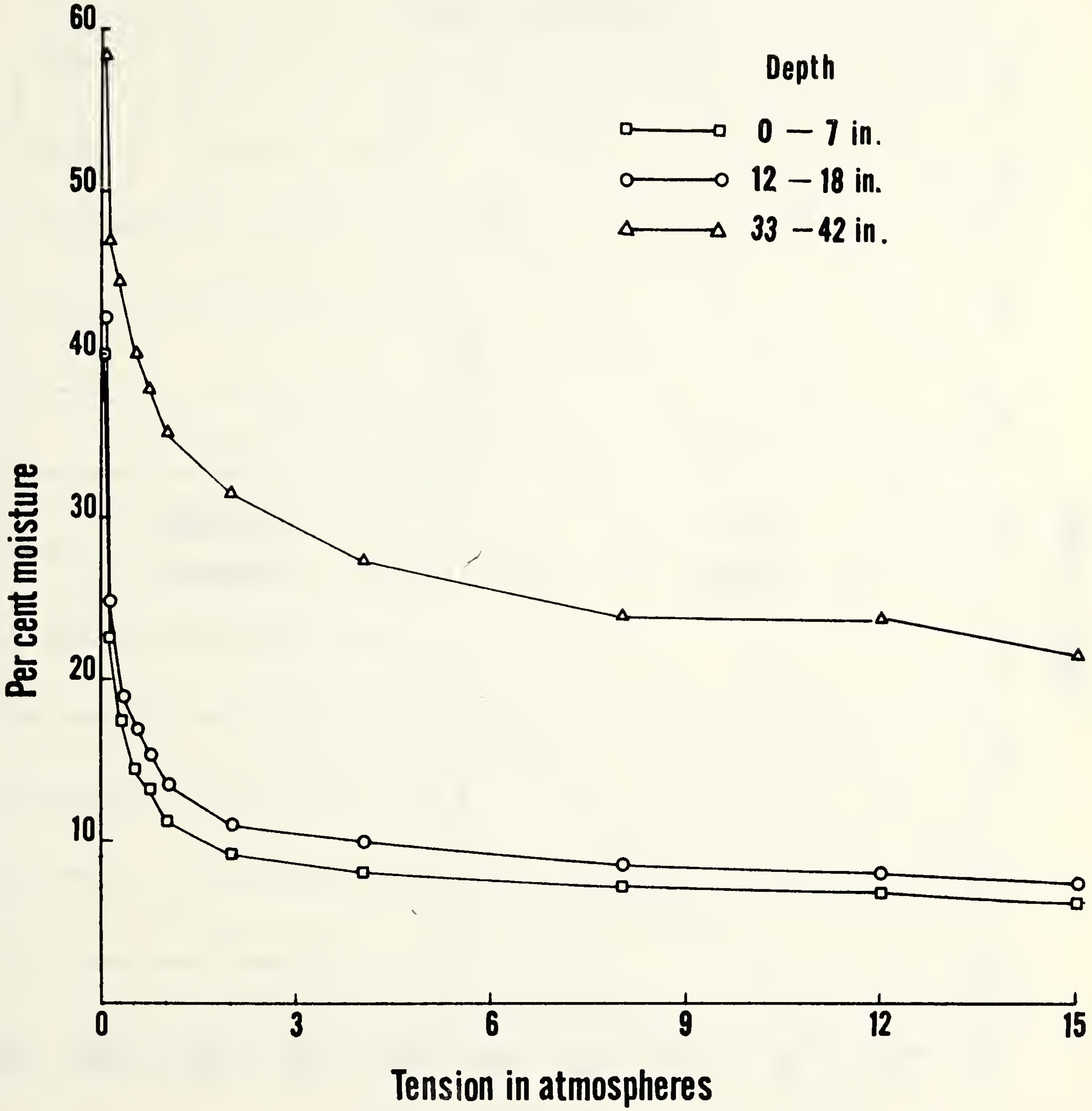


Figure 6. Moisture release curves for a Cypremort silt loam.

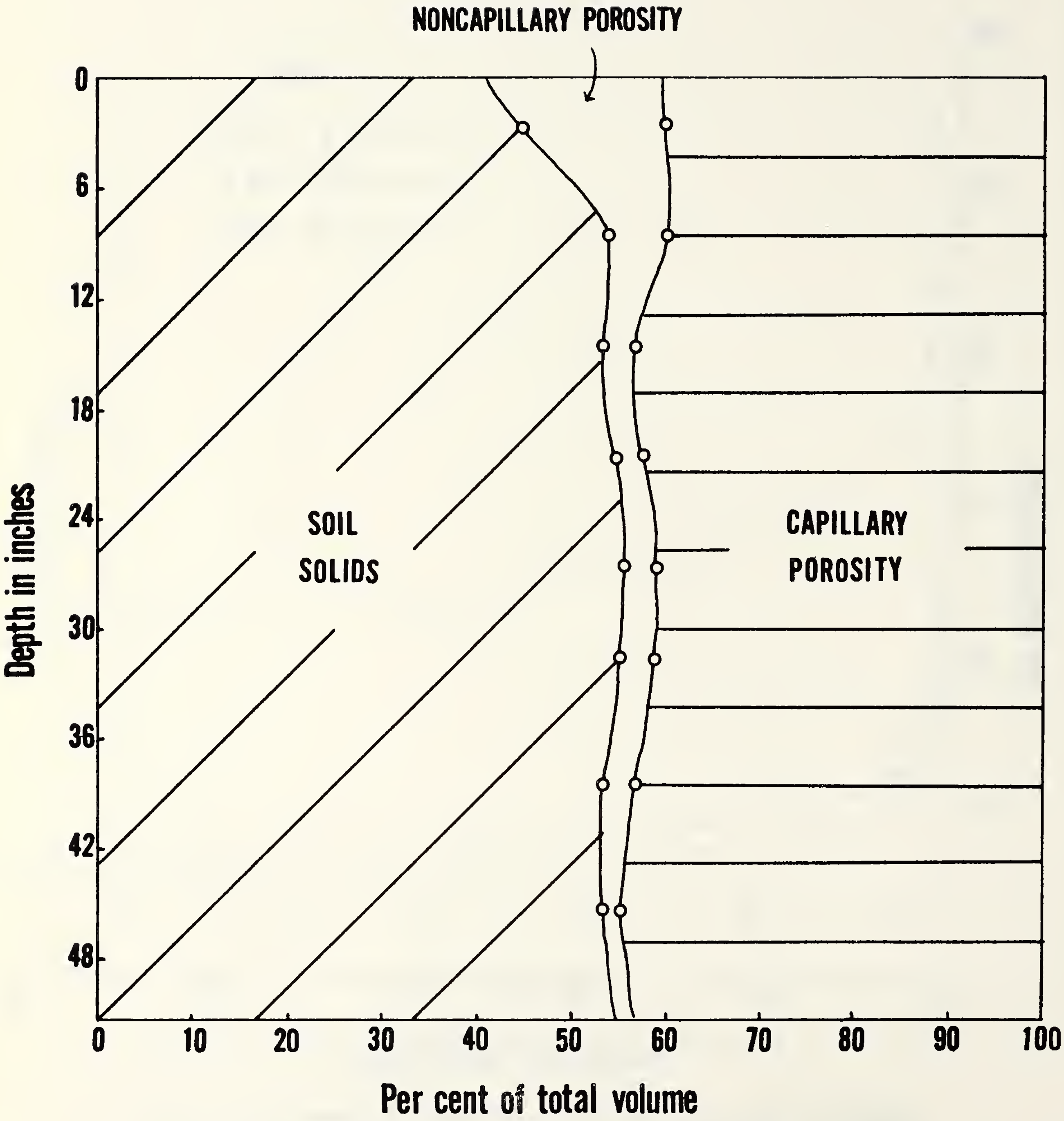


Figure 7. Volume distribution in a Baldwin silt loam.

accumulation of clay in this profile, as shown by Figure 8. The high clay content of the subsoil may be due to profile development, the deposition of layers of different texture, or both. The unfavorable distribution of pore sizes and slow water movement in the subsoil is related to the amount and kind of clay present. Moisture release curves for various depths are shown in Figure 9. The effect of texture on moisture release is indicated in this figure, with the medium textured surface soil retaining less water at a given tension than the fine textured subsoil.

Iberia Silt Loam

The Iberia soils are developed from clays deposited in the back swamps or slack water areas adjacent to the natural levees of the streams. Because of their low elevation and fine texture, both surface and subsurface drainage are poor.

The Iberia silt loam sampled has a low noncapillary porosity, or percentage of large pores, throughout most of the profile, Figure 10. Artificial compaction is evident directly under the plow layer at about the 8 to 12 inch depth. Some translocation of clay is indicated by an increase in clay content in the B horizon, Figure 11. The moisture release curves for various layers of this soil are shown in Figure 12. They show a fairly high water holding capacity for all horizons.

Mhoon Loam

The Mhoon soils are associated with the Commerce and Sharkey soils in the Mississippi River floodplain. They are more poorly drained

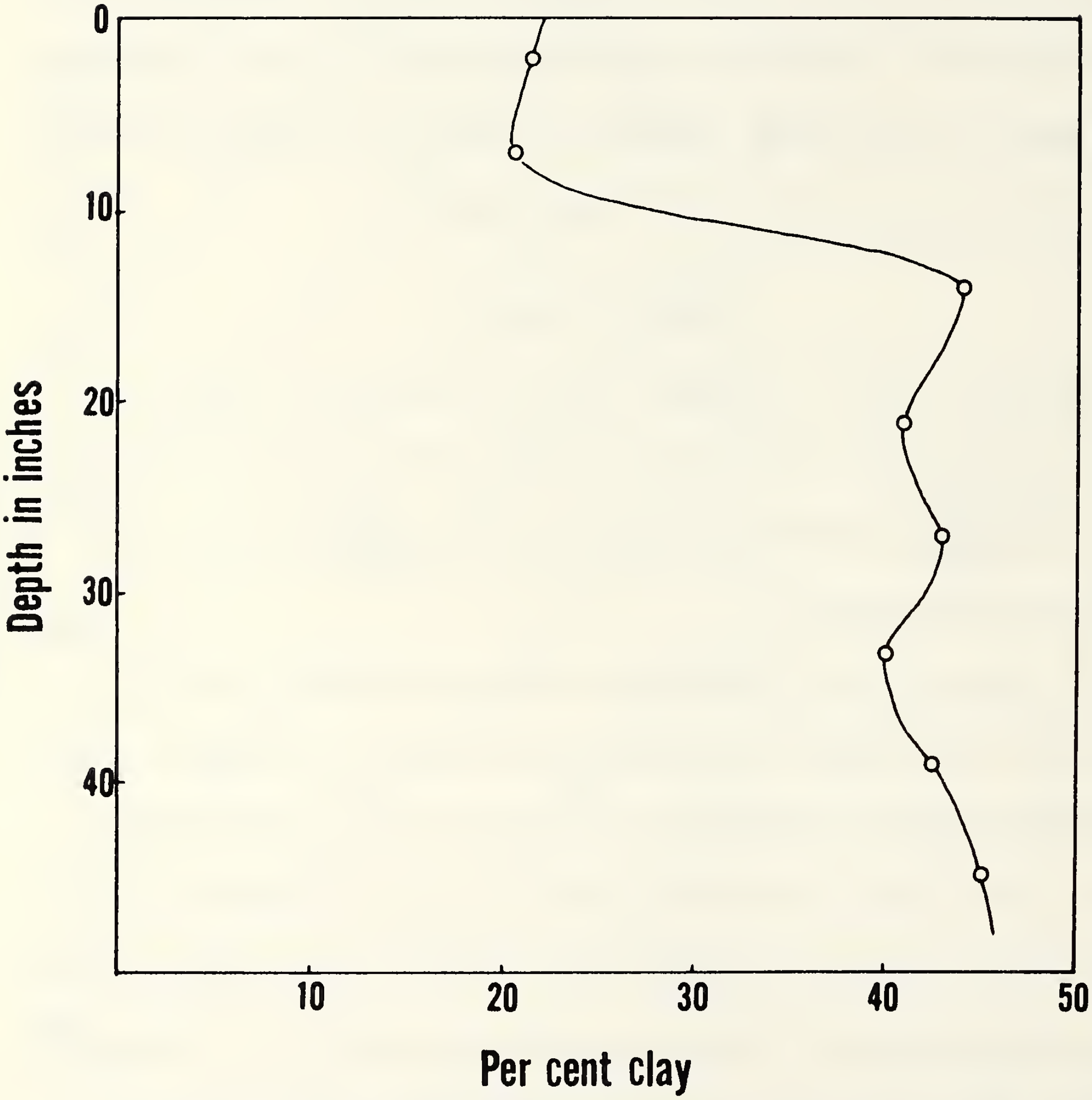


Figure 8. Clay content of a Baldwin silt loam.

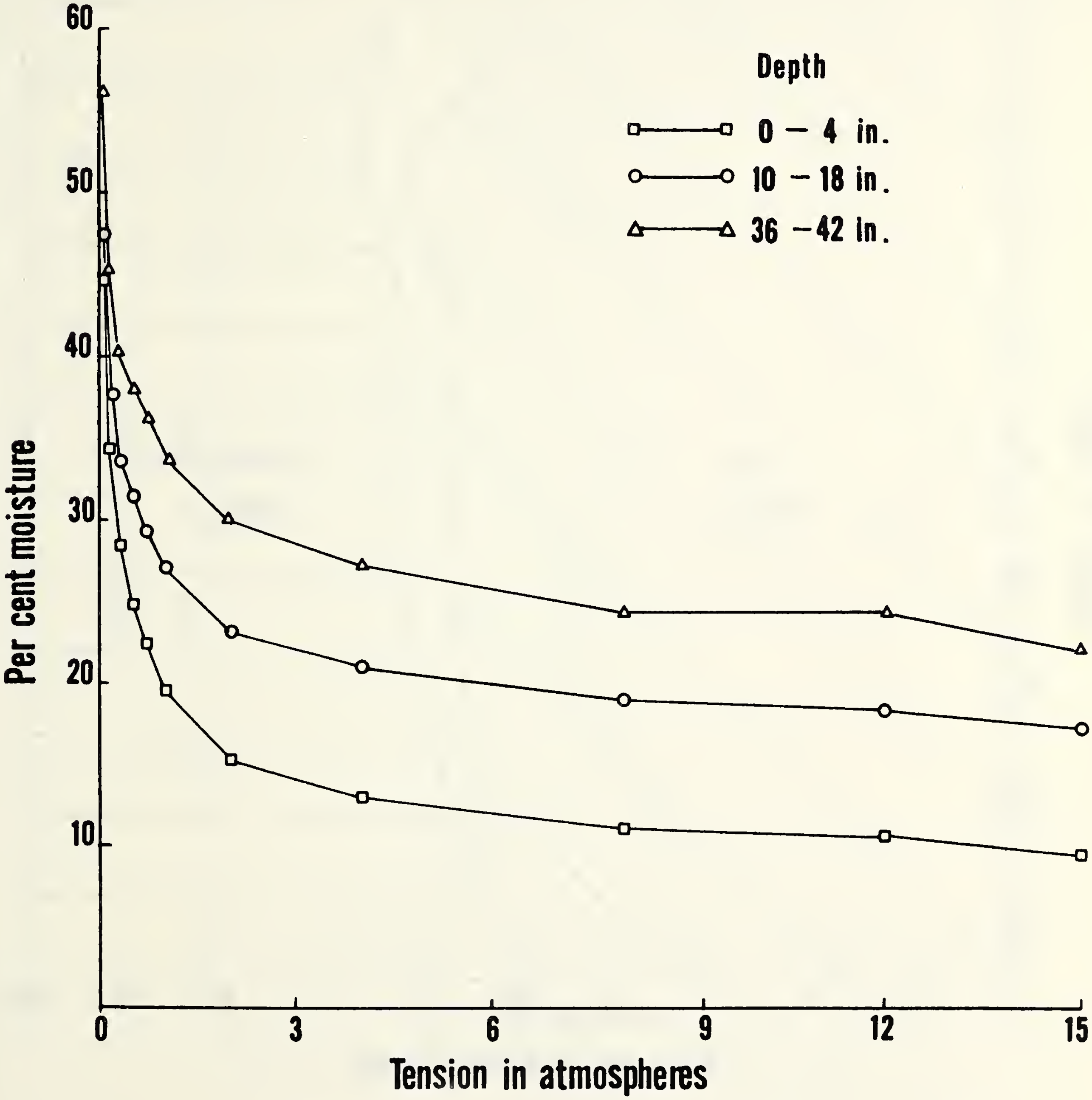


Figure 9. Moisture release curves for a Baldwin silt loam.

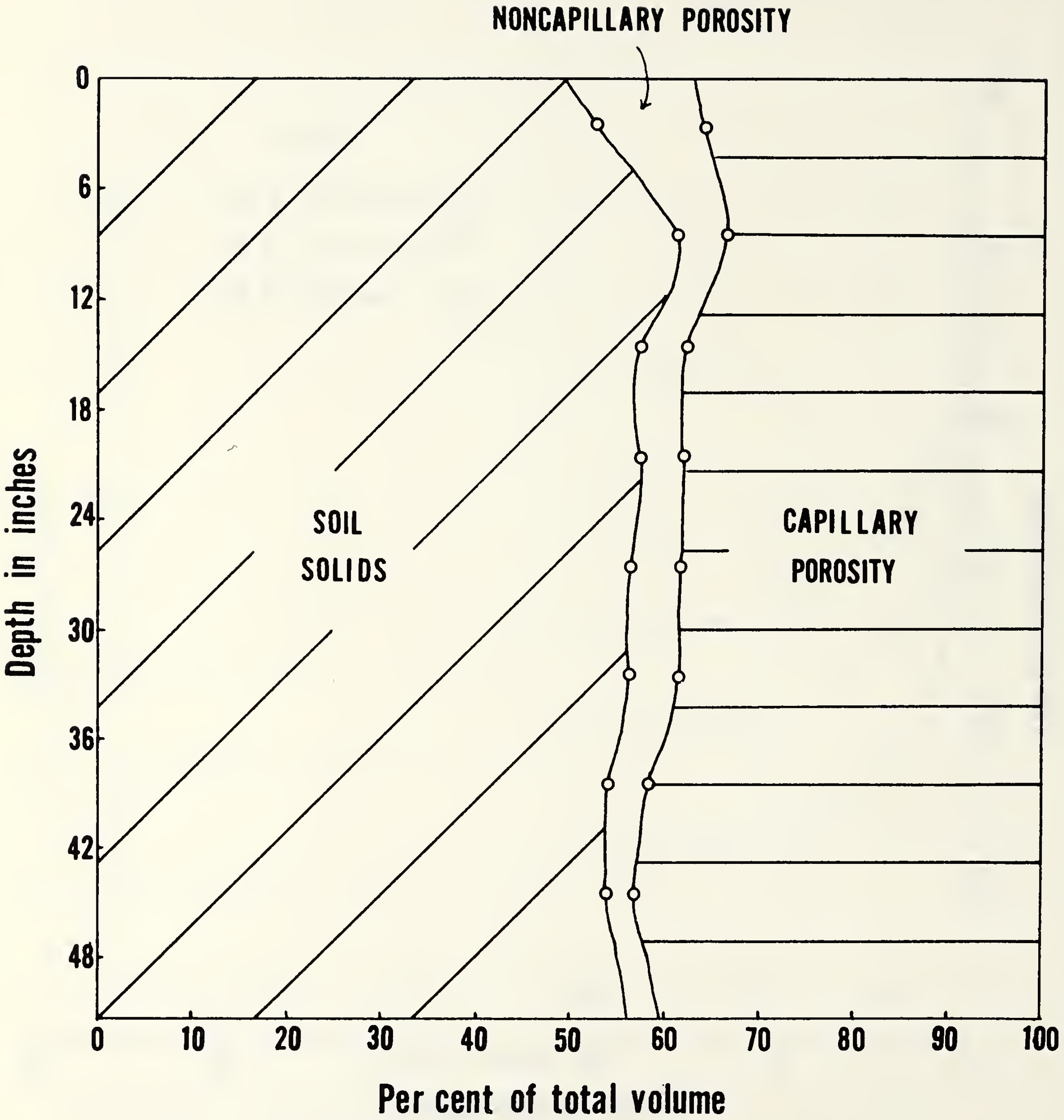


Figure 10. Volume distribution in an Iberia silt loam.

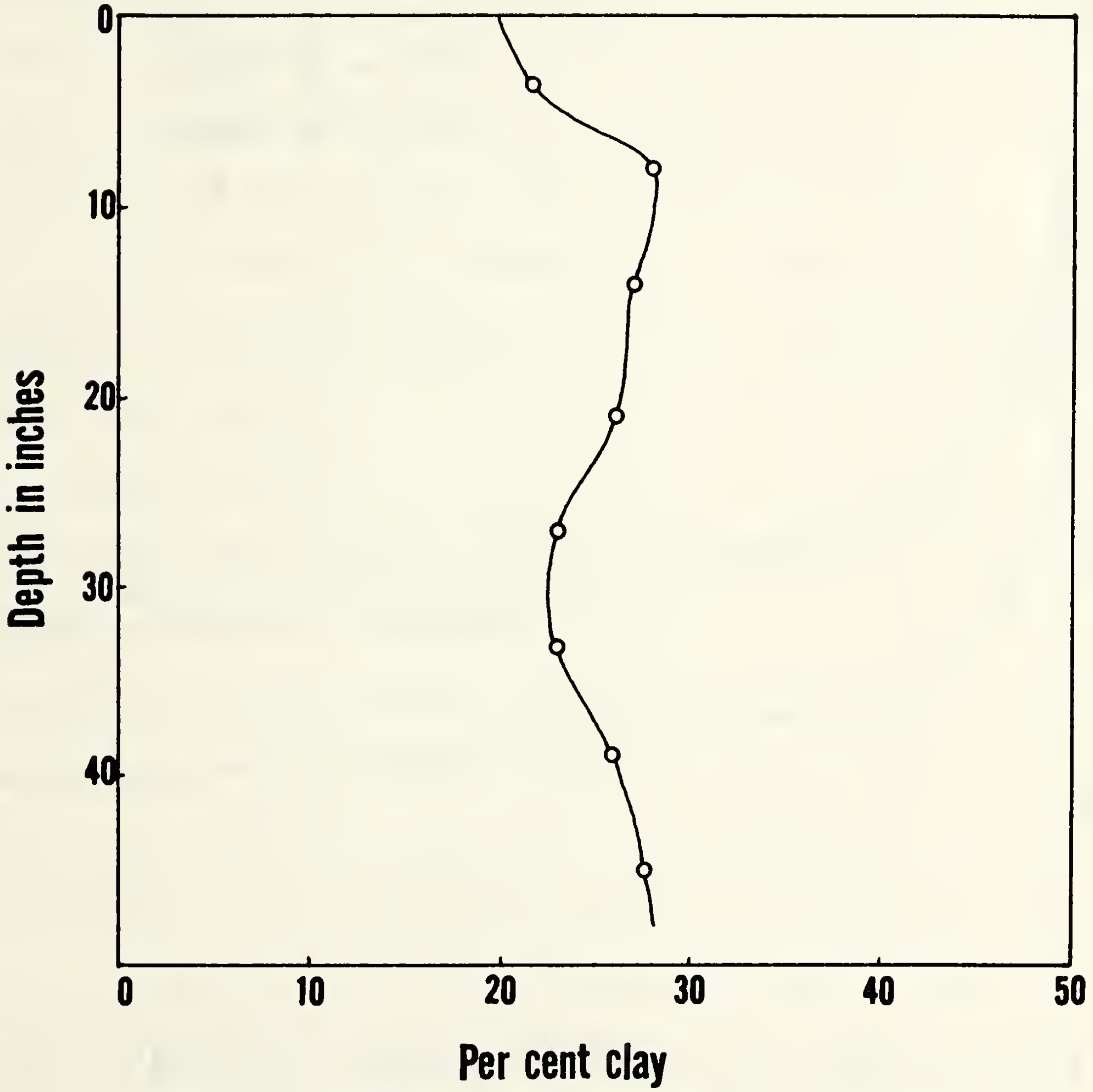


Figure 11. Clay content of an Iberia silt loam.

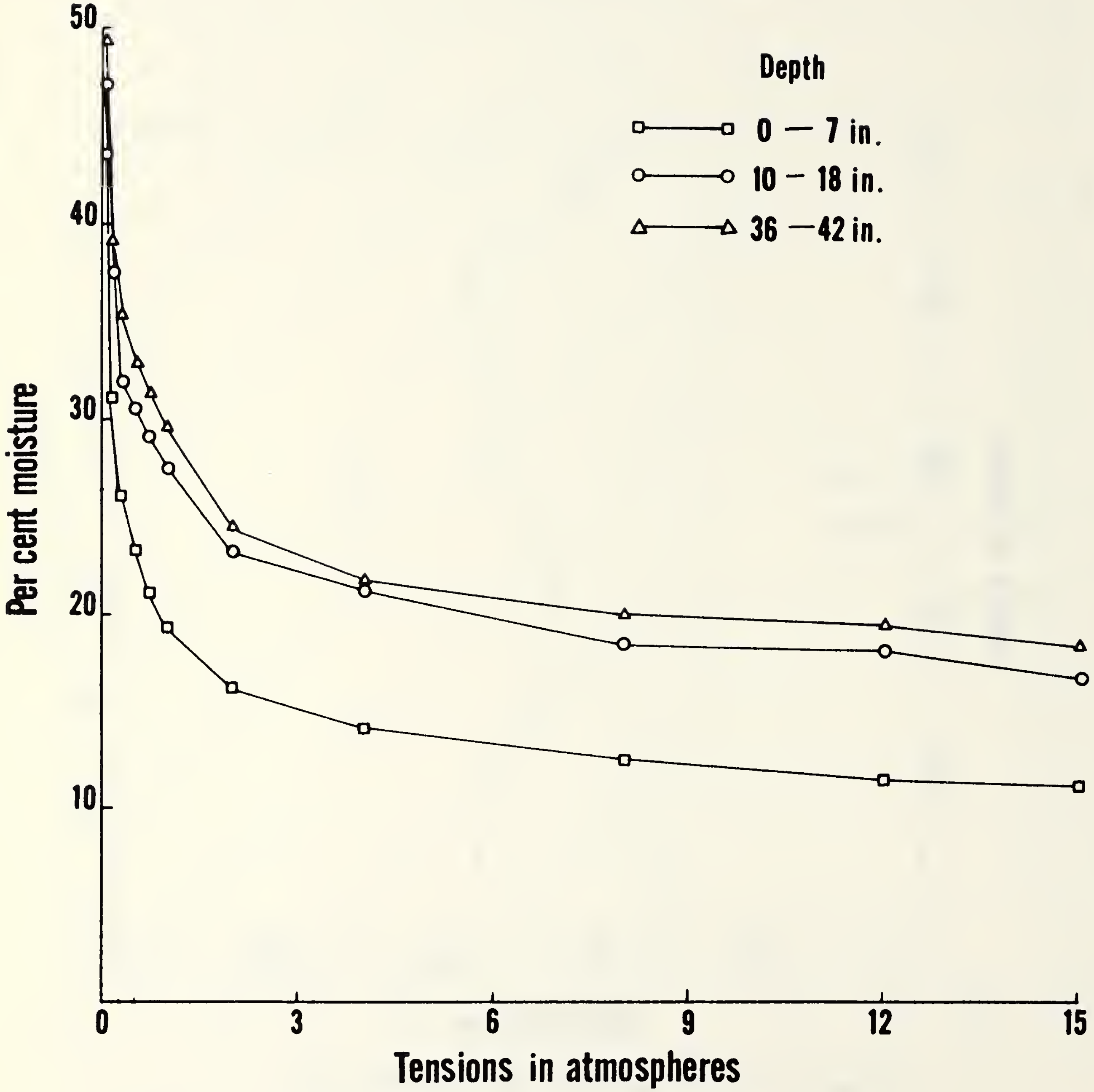


Figure 12. Moisture release curves for an Iberia silt loam.

and finer in texture than the Commerce soils and are better drained and coarser in texture than the Sharkey soils.

The Mhoon loam sampled is medium textured throughout the profile with a fairly high noncapillary porosity, Figure 13. Clay distribution in the profile, Figure 14, is due to sedimentation of materials of different texture, as this soil is not mature enough for pronounced eluviation of clay. The surface soil has a low water holding capacity, Figure 15. A large amount of water available to plants is held in the subsoil.

All of the above soils are characterized by rather poor internal drainage. For effective internal water movement a soil should have a noncapillary porosity of at least 10% throughout the profile. Not even the Cypremort silt loam approached this figure. The poor internal drainage of these soils is related to both the kind and amount of clay that is present in the profile. Pronounced swelling when wet and contraction when dry of the montmorillonitic type clays which are present in large amounts in the Mississippi River first bottom and Mississippi River terrace soils prevent the establishment and maintenance of large pores in these soils. When wetted, these expanded clay particles decrease the size of the soil pores. The high silt content of certain layers of these soils contributes to their poor structure. The structural stability of layers high in silt is low, and when these layers are compacted, particularly by machinery, the swelling forces in the silt are not great enough to cause expansion during a wetting and drying cycle. This results in a high bulk density and a low noncapillary porosity.

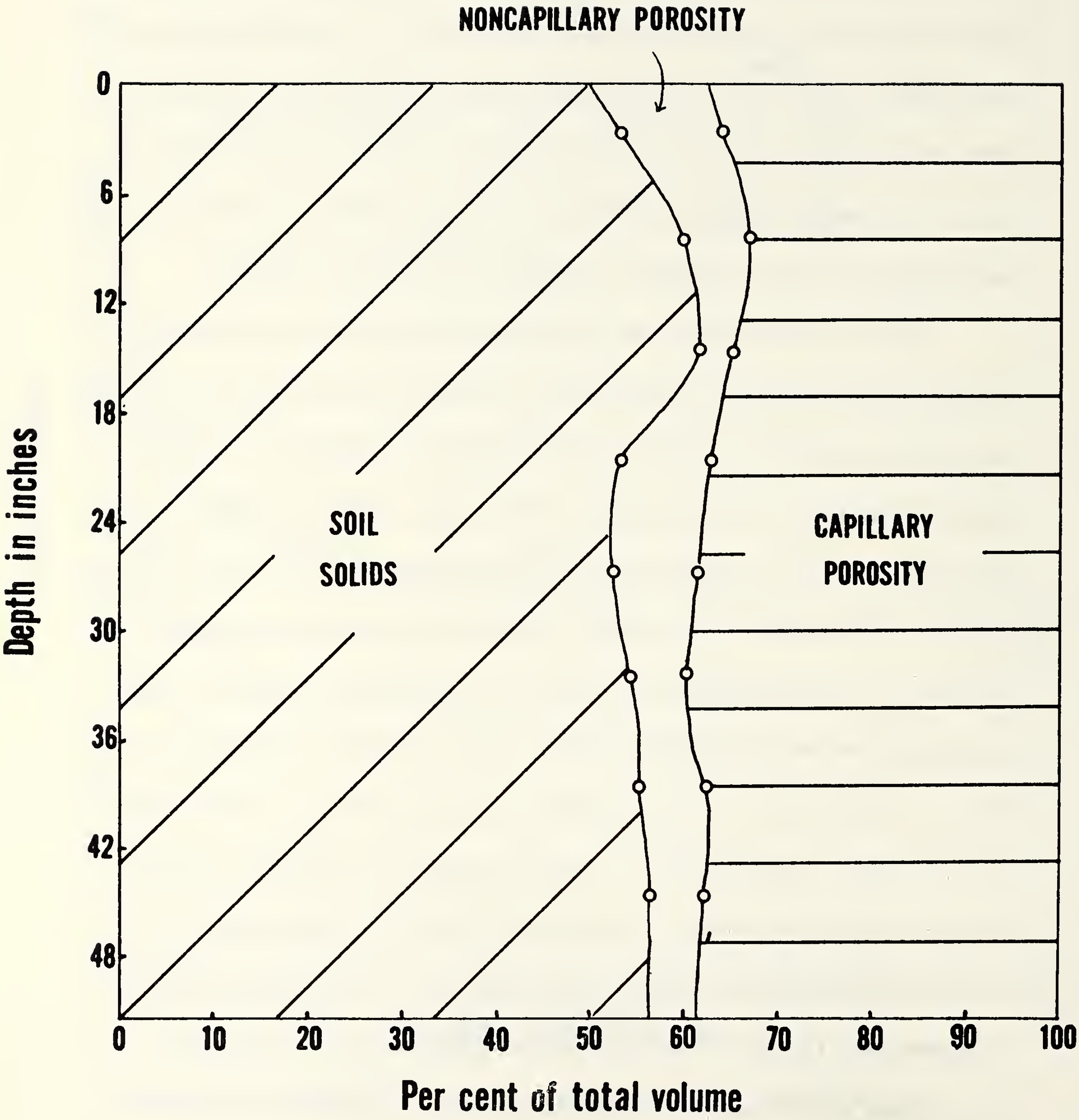


Figure 13. Volume distribution in a Mhoon loam.

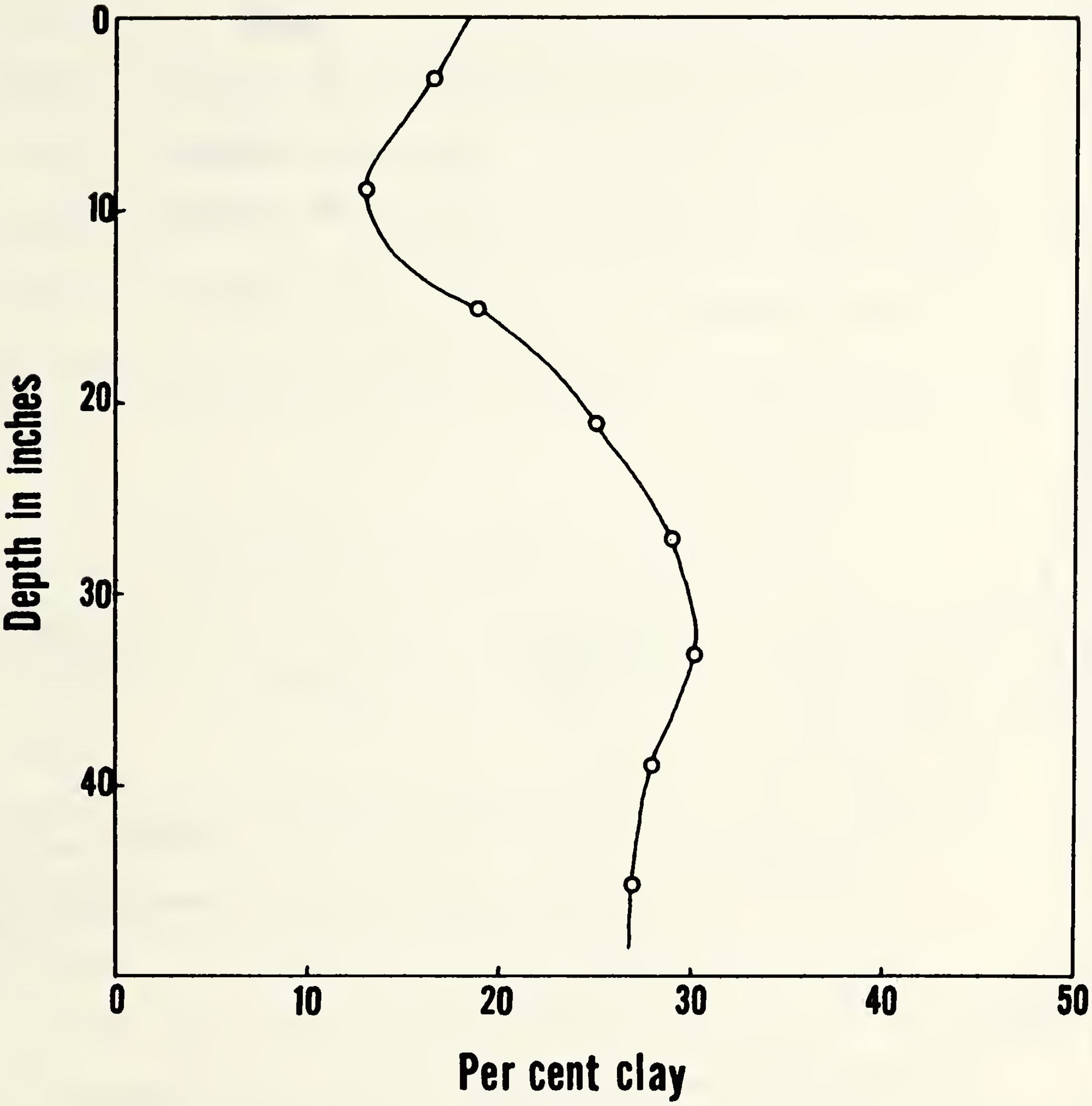


Figure 14. Clay content of a Mhoon loam.

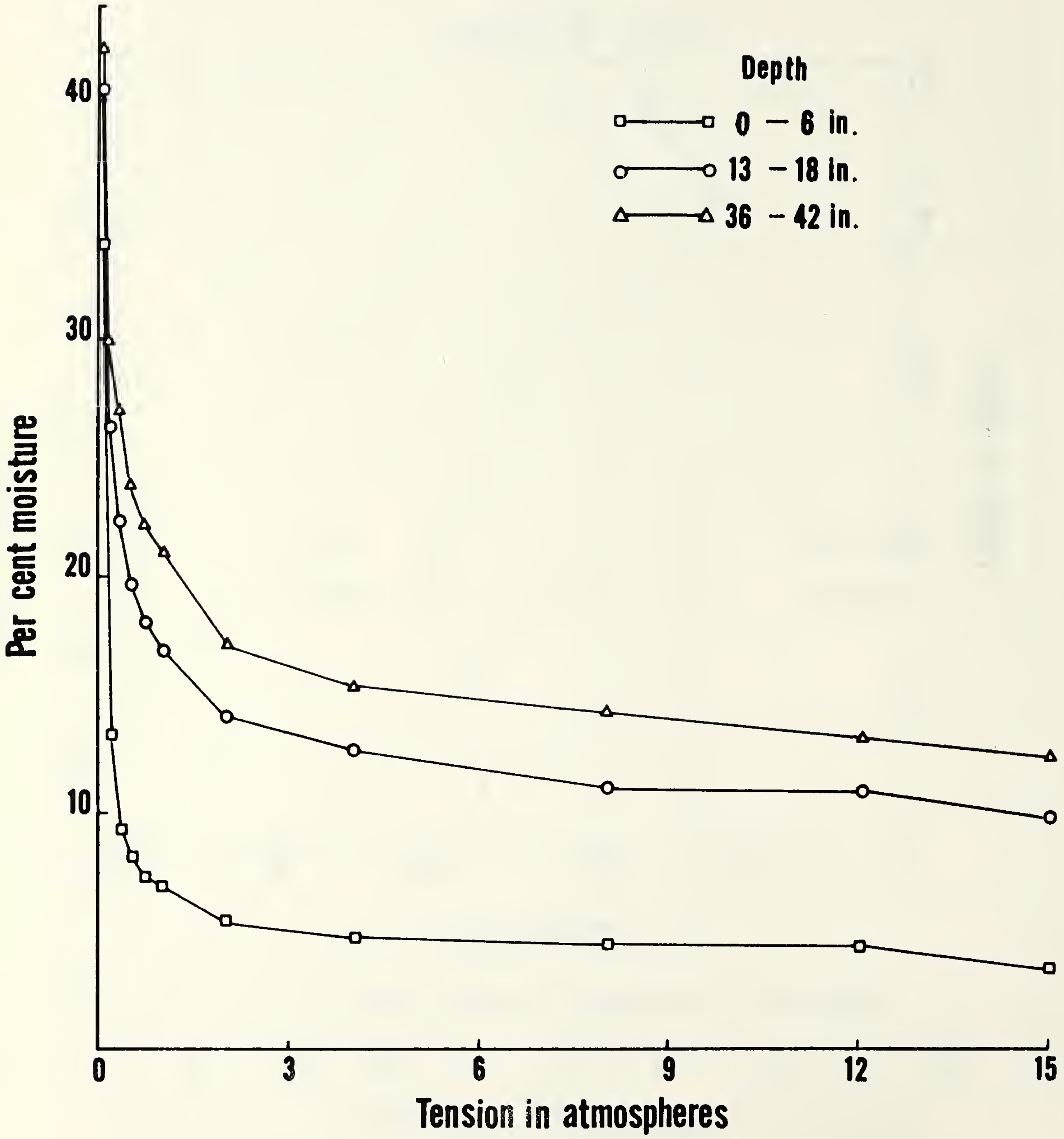


Figure 15. Moisture release curves for a Mhoon loam.

Correct management is extremely important with the moderately fine textured soils in the sugarcane growing area. Plowing these soils at too high a moisture content results in a deterioration of structure that is slowly reversible. This condition is illustrated by an experiment with Mhoon clay loam in which the effect of various treatments on the structure of the soil were measured. The treatments used were (1) Puddling the soil when wet, (2) mixing a synthetic soil conditioner (Krilium) with the soil, (3) incorporating a green legume, Melilotus alba, into the soil, and (4) untreated soil. Physical properties of these soils are shown in Table 1.

Table 1. Physical properties of Mhoon clay loam.

Treatments Used	Aggregation	Noncapillary Porosity	Water Permeability	Bulk Density
	%	%	in/hr.	gm/cc.
Puddled	7.0	5.3	0.16	1.45
Krilium added	32.7	10.7	0.52	1.31
M. alba added	26.1	14.6	1.51	1.24
Untreated	22.6	8.8	0.35	1.33

The most striking result of this experiment is the almost complete deterioration of structure as a result of puddling the soil. Three months after puddling, the aggregation, noncapillary porosity or percentage of large pores, water permeability, and bulk density values showed an extremely poor structure as compared to the untreated soil. The addition of Krilium markedly improved the aggregation of the soil. The structure of this soil was also improved by the use of a legume, Melilotus alba. Aggregation, noncapillary porosity, water permeability, and bulk density were all improved by incorporating the legume into the soil.

In an additional study designed to determine how much improvement in structure of the Mhoon soil could be brought about by the use of the synthetic soil conditioner, several rates of Krilium were added to samples of the soil and allowed to incubate. Figure 16 shows that adding the soil conditioner resulted in over 90% of the total mass of this soil being formed into water-stable aggregates larger than 0.21 mm. diameter.

Another example of the effectiveness of legumes in maintaining favorable soil structure is shown in the results of a laboratory and field experiment on Commerce loam (4). This soil is similar to the Mhoon soil but is coarser textured and better drained. In this experiment, a leguminous cover crop, hairy vetch, was grown every year and turned under in the spring. Also included in the experiment were a treatment that received fertilizer nitrogen every spring and an untreated check. All plots were planted to cotton every year. These treatments were continued for 25 years. Certain physical properties of this soil at the end of this time are shown in Table 2.

Where no cover crop was grown, the soil organic matter content was very low as compared to the organic matter where hairy vetch was grown. The physical properties of aggregation, bulk density, noncapillary porosity and permeability were all in line with the organic

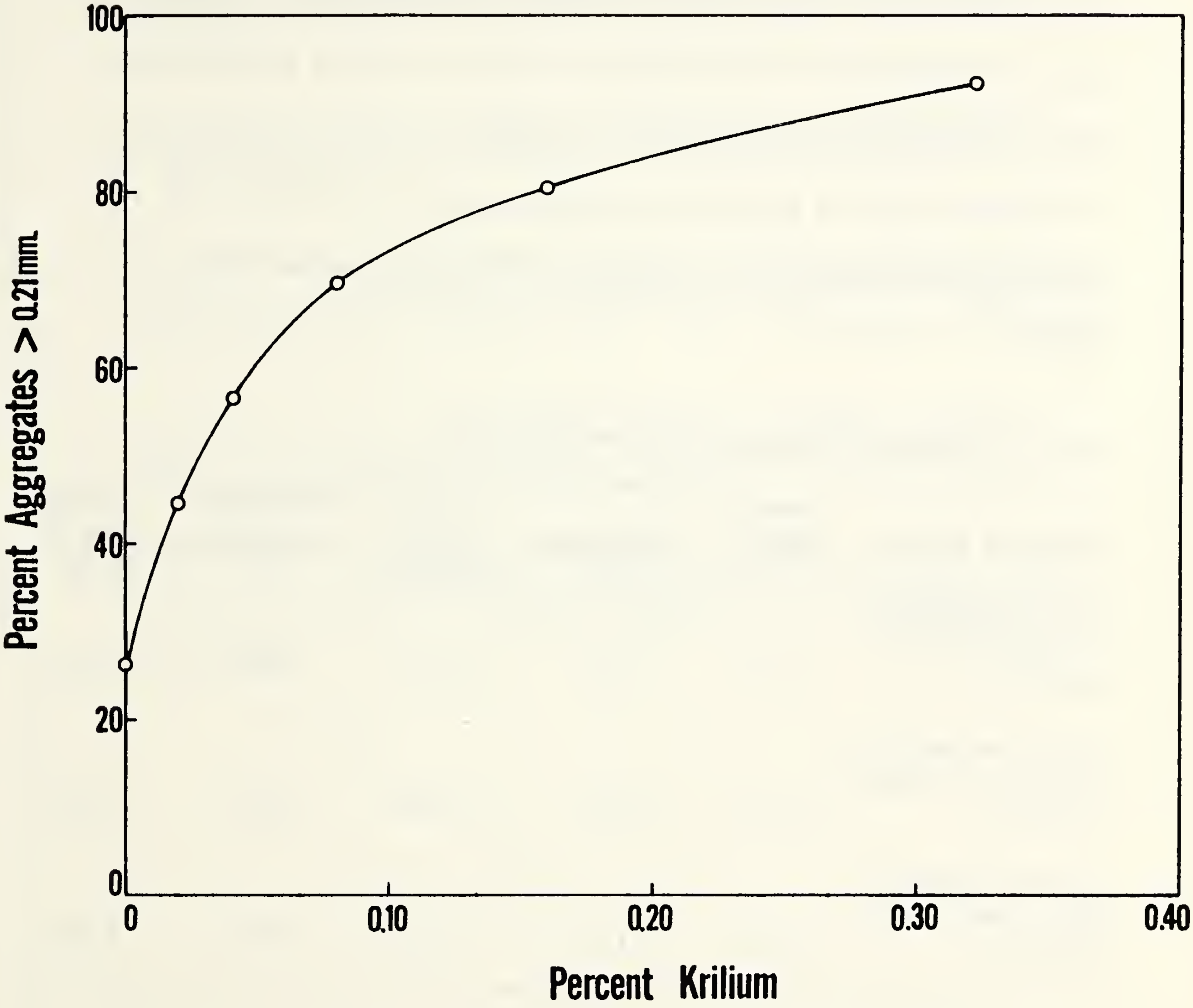


Figure 16. Aggregation of Mhoon clay loam as affected by concentration of soil conditioner.

matter contents, with a poor physical condition indicated for all of the plots without vetch. The addition of fertilizer nitrogen increased the amounts of crop residue turned under, but this increased residue had no effect in increasing organic matter or improving the physical condition of the soil. The data from the above studies strongly suggest that the maintenance of organic matter and the favorable physical conditions associated with higher level of organic matter in the soils of the sugarcane area is dependent on turning under large amounts of leguminous plant material in addition to the nonleguminous crop residues.

Table 2. Physical Properties of Commerce Loam

Treatment Used	Organic Matter	Aggregation	Bulk Density	Noncapillary Porosity	Permeability
	%	%	gm/cc.	%	in/hr.
Cotton annually. No cover crop or Fertilizer.	0.65	9.5	1.37	15.7	0.32
Cotton annually. 40 lb/acre N added annually.	0.72	10.2	1.36	14.5	0.45
Cotton annually, Hairy vetch grown annually.	1.21	21.3	1.32	17.8	0.58

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A NEW APPROACH TO MECHANICAL HARVESTING OF SUGAR CANE

R. E. Shafer

Is the present method of harvesting and milling sugar cane satisfactory? Here in Louisiana we know the number of growers and the number of sugar mills are decreasing. They must be decreasing for a reason, and in most cases, the reason given is that they have found it to be uneconomical to grow and/or process sugar cane. All will agree that the quantity of sugar being used in the United States is increasing yearly, therefore, if the Louisiana cane industry is going to stay in business, a better means of growing, handling and processing sugar cane must be found. This new method of harvesting is proposed so that it will be more economical and more profitable to the producer and processor of sugar cane. Since the price of sugar is more or less fixed by our Federal Government and the cost of growing, harvesting, and processing cane is gradually increasing, it becomes necessary for the industry to find cheaper and better methods. The best solution at this time for a more economical method of harvesting sugar cane appears to be a combine type harvester. So it is necessary for us to analyze the principles of this system to see whether or not it is feasible.

This harvester is to cut the cane top and bottom, clean and load it all in one operation such that there will be less man power required and fewer pieces of equipment to maintain. This unit, designed to straddle two rows is self-propelled by a tractor engine. The harvester will not be mounted on a tractor, but will be constructed on its own frame. From past experience the tractor unit castings have been found to be too light to carry a harvesting unit of this type. Although straddling two rows, the machine will cut one row at a time. By straddling two rows the machine will have a low center of gravity such that it can run on rather sloping terrain which is hardly practical with the harvesters now in use. The propulsion unit will be capable of producing about 50 HP. The harvester will use a light weight power unit to drive the mechanism with a rating of 100 HP or better. The Cary pickup system which was originated about 10 years ago will be used. To the front of the pickup mechanism, is located a pair of dividers which makes it possible to harvest entangled and down cane even after or during a wet season. The large scrolls and cutting blades, larger than on the prototype model, are controlled hydraulically by an operator who also controls the steering, the speed and the dividers. After picking up the cane it will be cut in 15 inch lengths by knives mounted to the rear of the cutters and rotating crosswise of the feed bed.

The cutting of the cane in lengths is the means for cleaning and selective topping. The separation of trash and tops from the cane is accomplished by the difference of the density and the resistance of cutting between the trash and tops from the cane stalk itself. The short lengths of cane continues on into the elevator while the tops and trash are thrown out on the ground below the machine. This process is very simple and does not clog or choke as experienced by previous methods. The elevator carries the cane upwards and drops it into a hopper mounted at the rear of the machine. A blast of air from a fan mounted under the elevator is blown through the cane as it falls into the hopper separating the loose trash from the cane. In the picking up of the butt of the cane and the cleaning process of cutting it in small pieces the cane is handled roughly so that most of the dirt or mud is removed from it. This experience was attained with previous models. What does fall loose on the elevator then is separated by a louverd bottom letting the dirt fall out on the ground under the machine. During muddy conditions, the shaking of the cane caused by the pickup scrolls will remove most of the mud that may be on the stalk of cane. This process of picking up the cane lets very few stalks touch the ground which helps keep the cane clean. The hopper which stores from 2000 to 3000 pounds of cane will have a discharge conveyor that will load the cart directly on the left side of the machine. This conveyor will be controlled by a second man sitting in the rear of the hopper in such a position that he can control the loading operation from his vantage point. This gives the machine the unique feature of continuing operation while replacing full carts with an empty one. With the hopper, when the machine comes to the end of a row it is not necessary to unload the machine before starting the next row or to wait for the cart to position itself. Instead the machine can go on and start the new row and let the cart catch up with it. With this storage facility, the cutting time of the machine should be increased at least 25 percent.

In previous operations there was considerable delay with turning at the end of a field and when changing carts.

This machine, weighing approximately 14000 pounds, is equipped with two rear tires, 18" x 26", and one front tire, 16" x 16", which gives the harvester better floating, in muddy fields, than most present cane carts. The combine is designed to operate with little maintenance. The main drives and all other drives that have enough speed will use either poly-v belts or regular vee belts. This eliminates several chain drives which give considerable trouble in dusty and muddy conditions. Slow speed drives will of necessity have to be chain drives, which will be force lubricated in all cases except those that run in the dirt, such as our pickup chains. This harvester will be built in units and mounted such that they will be readily removed in case of trouble and can be replaced in the field quickly. All bearings used will be anti-friction type with seals and anti-wrap shields will be used where necessary. General greasing will be required only once a week. The daily maintenance will consist of replenishing the oil in the lubrication system and, of course, servicing the two engines. This machine is estimated from past experience, to have a capacity of 200 to 250 tons per day with a cutting rate of 35 to 45 tons of sugar cane per hour. The capacity is very dependent on the conditions such as field layouts and personnel operating it. The cost of this machine is estimated at $20,000.00 at present cost conditions when built in small quantities. If demand becomes great enough this price could probably be reduced 10 or maybe 15 percent.

Many people have objected to cutting cane in short pieces, as it offers some problem in handling the cane. Actually the handling of short pieces offers more different means of handling than long pieces. It is true that the present sling method of handling cane will not be satisfactory for handling the short pieces, however, the net method is readily adaptable. The present carts will have to be revised some such as solid sides and bottoms with some method for unloading rapidly. There are several methods of unloading these carts, one would be using nets, another would be to dump the cane down through the bottom of the cart and still another, would be lifting the body off the wheels and dumping the cane from it. It is probable someone will develop even better and more satisfactory methods than outlined here. For the present, with small usage of this type of machine, probably the net method would be the most economical. Storing the cane at the farm will be some sort of problem at the start either requiring extra trailer or storing on the ground and loading with grabs into these trailers when they are available. A pit in which the cane is dumped and then loaded by an elevator into trailers may be a practical method of storing cane on large operations. This installation would be expensive to install but very economical to operate.

When cane is delivered to the mill there are several means to handle it. Using nets in the trailers or in the carts would be one method. Bottom, side or rear dump truck and carts are other methods that may be used. The cane can be dumped on conveyors or on concrete slabs. If the cane is dumped on a slab then it can be moved, either by grabs or pushed with a dozer. If pushed by a dozer a conveyor should be arranged such that it will load the feed conveyor to the mill. These should offer no big problem to the mills.

Now let us review our analyzation of our new method starting at the front of the machine and progressing toward the rear. The type of pickup and divider that will be used are not new. This system was experimented with in Cuba and was found satisfactory. Some changes have been made but nothing basically has been changed. Then, the next step is the cutter pickup devise. This has been used in Louisiana, Florida and Cuba and was found satisfactory. At present, it is the only known method of picking up down tangled cane and topping it selectively. The cleaning in this topping process has, also, proven satisfactory and is basically the same principle now used in Cuba by hand harvesting. In test this method was found to clean cane as low as 3 percent. The use of a storage bin on a cane harvester is a new approach, but has been used in several agricultural harvesters such as rice, cotton, and wheat. This approach has been found to be a sound method of maintaining the harvester in operation the largest percentage of time possible. No trouble was experienced in loading directly into a cart from a harvester. However, without the storage system, the percentage of operating time of the harvester was lowered because time lost while the carts were being changed and while at the end of the rows when the carts had to leave the harvester discharge. Since this harvester will be able to cut 2 or 3 minutes without a cart directly under the discharge very little delay should be caused in the synchronization of the carts with the operation of the harvester.

The greatest problem in building a satisfactory harvester will be building one that will continue to harvest regardless of weather or cane conditions. No trouble is anticipated in overcoming these difficulties.

There has been some objections to cutting cane in short pieces such as 15 inches in length as proposed. However, in Cuba this proved satisfactory. In tests made there, the purity loss was negligible in 72 hours. Also, the weight lost was not appreciable within 72 hours and they considered the 15 inch pieces very satisfactory. The weight loss should not be as great as the loss when the cane is burned in the field.

The principle of a single operation in harvesting is not new and is used on several agriculture crops and all have proven economical. Some of these new harvesting methods have required a large investment for small farmers. However, these obstacles have been taken in their stride and now cotton, corn, rice, potatoes, sugar beets and wheat are all harvested in a single operation. The combining of rice required large installations of rice dryers and storage facilities. This was accomplished and greatly benefited the industry. The mechanical harvesting of cotton, also, necessitated the adding of expensive machinery to the gins so a reasonable good sample of cotton could be produced.

So why should this new method of harvesting sugar cane cause such a great concern? Whether the industry sees fit to use the Cary method or some other method of harvesting and since the present system has been exploited to about its limit, it is time for the industry to try something new that shows promise of being better. Judging by other crop harvesters, the most economical system of harvesting sugar cane points to a combine type of harvester such as proposed.

TESTING CANE DELIVERIES FOR TRASH

A COMPARATIVE STUDY

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This is a brief report of a program conducted during the 1957 Louisiana grinding season to determine the effectiveness and reliability of current procedures for measuring the trash content of commercial deliveries of sugarcane. This work was done by and through the cooperation of the 35 cooperating factories and the State Committee, ASC.

Tests were conducted over a period of approximately six weeks out of the eleven week grinding season. An approximately equal number of tests were made each week so that conditions prevailing throughout the season could be compared. The data are presented in Tables I and II.

The procedure employed was as follows: A representative of the factory and the State Committee, ASC, selected a cane delivery for the test which they considered to be typical of deliveries to that plant at the time. The selected delivery was sampled for trash by the procedure normally employed at the factory and its trash content determined. The rest of the delivery was then weighed, detrashed and reweighed to determine its actual trash content.

Table I. Comparison of Trash Determinations in Commercial Cane Deliveries. Sample Analysis Versus Entire Delivery

	Trash Determination		Ratio	Weather Conditions		General	Method of
Factory	Sample Results	Shipment Results	Shipment to Sample	A	B	Conditions of Cane	Piling Cane
1	8.03	11.38	1.417	Sunny	M. Breeze	1	Chain-shaker
2	4.31	13.14	3.049	Cloudy	M. Breeze	1	Pusher
3	23.60	20,50	0.869	Sunny	Calm	1	Pusher-Shaker
4	3.40	5.17	1.519	Sunny	M. Breeze	1	Pusher
5	2.36	6.64	2.814	Sunny	M. Breeze	1	Pusher
6	9.50	14.35	1.511	Cloudy	M. Breeze	1	Chain-shaker
7	3.92	9.35	2.385	Cloudy	M. Breeze	1	Other
8	4.50	9.36	2.080	Cloudy	Calm	1	Pusher-shaker
9	11.11	8.74	0.787	Sunny	M. Breeze	1	Pusher-shaker
10	2.00	9.09	4.545	Cloudy	Windy	1	Pusher-shaker
11	4.64	10.40	2.241	Sunny	Calm	1	Chain-shaker
12	9.21	12.60	1.368	Sunny	M. Breeze	1	Chain-shaker
13	5.18	15.50	2.992	Cloudy	M. Breeze	1	Chain-shaker
14	5.26	8.82	1.677	Cloudy	M. Breeze	1	Pusher-shaker
15	8.45	12.98	1.536	Foggy	Calm	1	Pusher-shaker
16	11.40	21.98	1.928	Sunny	Calm	1	Pusher-shaker
17	8.05	14.18	1.761	Sunny	Windy	1	?
Averages	7.349	12.011	1.634				
18	6.96	10.22	1.468	Sunny	Calm	2	Pusher
19	9.47	22.09	2.333	Cloudy	Calm	2	Chain-shaker
20	3.82	8.30	2.171		Windy	2	Pusher-shaker
21	6.84	20.23	2.958	Cloudy	Calm	2	Pusher-shaker
22	11.17	20.27	1.815	Cloudy	M. Breeze	2	Pusher-shaker
23	17.20	21.50	1.250	Cloudy	M. Breeze	2	Chain-shaker
24	10.50	23.39	2.228	Rain	M. Breeze	2	Pusher-shaker
25	17.65	18.03	1.022	Sunny	Calm	2	Chain-shaker

(Continued on next page)

Table I. (Continued)

Factory	Trash Determination Sample Results	Trash Determination Shipment Results	Ratio Shipment to Sample	Weather Conditions A	Weather Conditions B	General Conditions of Cane	Method of Piling Cane
26	20.04	24.76	1.236	Rain	M. Breeze	2	Chain-shaker
27	14.50	14.45	0.997	Cloudy	Calm	2	Pusher
28	9.76	13.24	1.357	Cloudy	Windy	2	Pusher-shaker
Averages	11.601	17.862	1.540				
29	13.11	27.19	2.074	Cloudy	M. Breeze	3	Pusher
30	6.54	12.90	1.972	Rain	Calm	3	Pusher-shaker
Averages	9.825	20.045	2.040				
31	13.50	13.45	0.996	Sunny	M. Breeze	4	Chain-shaker
32	11.46	18.03	1.573	Sunny	Calm	4	Pusher-shaker
33	19.52	27.60	1.414	Sunny	M. Breeze	4	Mule-rake
34	22.60	28.80	1.274	Rain	Calm	4	Chain-shaker
Averages	16.770	21.970	1.310				
35	11.42	29.60	2.592	Cloudy & Foggy	Windy	1-2	Pusher-shaker
Averages	11.420	29.600	2.592				
Overall Averages (Cane Condition)	10.020	15.949	1.592				

Trash content of deliveries by sampling ranged from 2.00% minimum to a high of 23.60% compared to minima and maxima of 5.17% and 29.60% when the entire load was detrashed. Four of thirty-five tests indicated more trash than was found when the entire shipment was detrashed. The average % trash by sample test was 15.43% while the actual trash in the bundle was 14.29%, a difference of 1.14%. The other 31 tests showed considerably more trash in the shipment than indicated by the test, 10.02% average on 35 tests compared to an actual trash in the bundle of 15.95%.

In an attempt to determine the effect of weather and condition of the cane on the accuracy of the determination the data have been arranged according to condition of cane, i.e., unburned, well burned, etc. This arrangement appears as Table I. A measure of the correctness of the determination has been obtained by use of the ratio - % trash in shipment/% trash in sample. No clear cut relationship developed from this analysis. Ratios varied within the range 1.310 to 2.040 and the overall average was 1.592.

The type machine employed for piling the cane prior to loading in carts was expected to have a pronounced effect on the accuracy of the determination. Some pilers increase the amount of soil in deliveries when carelessly operated. A tabulation according to type of piler appears in Table II. Most favorable results were obtained with the chain-shaker piler. The pusher and the pusher-shaker were less effective, that is, the difference in trash content between the sample and the shipment was greater which might indicate a greater inclusion of soil in the cane deliveries.

It appears, on the basis of these tests, that the trash content of cane deliveries as determined by current procedures is much lower than that actually present in the cane. Trash tests on the average would have to be multiplied by a factor of 1.592 to obtain the amount of trash actually present in the bundle. In 17 cases the ratio was less than 1.592 while in 18 cases it was greater than this figure.

The cost to the factories in the state of an inadequate sampling procedure is estimated at about $1,687,000 on a 5,500,000 ton crop of sugarcane and the 1957 average trash figure of eight per cent.

To obtain some idea of the composition of the trash found in cane deliveries the factories which ran tests in the later part of the season were requested to separate the trash into the following categories:

1. Loose or attached cane tops.
2. Leaves
3. Soil
4. Miscellaneous

The total weight of trash was to be considered as 100 per cent and the composition calculated on the basis of the above divisions. Only seven factories reported this information so that the sample is relatively small. For what it may be worth the following table is submitted.

Table II. Comparison of Trash Determinations in Commercial Cane Deliveries. Sample Analysis Versus Entire Delivery

Factory	Trash Determination Sample Results	Trash Determination Shipment Results	Ratio Shipment to Sample	Weather Conditions A	Weather Conditions B	General Condition of Cane	Method of Piling Cane
1	8.03	11.38	1.417	Sunny	Mild Breeze	1	Chain-shaker
6	9.5	14.35	1.511	Cloudy	Mild Breeze	1	Chain-shaker
11	4.64	10.40	2.241	Sunny	Calm	1	Chain-shaker
12	9.21	12.6	1.368	Sunny	Mild Breeze	1	Chain-shaker
13	5.18	15.5	2.992	Cloudy	Mild Breeze	1	Chain-shaker
19	9.47	22.09	2.333	Cloudy	Calm	2	Chain-shaker
23	17.2	21.50	1.250	Cloudy	Mild Breeze	2	Chain-shaker
25	17.65	18.03	1.022	Sunny	Calm	2	Chain-shaker
26	20.04	24.76	1.236	Rain	Mild Breeze	2	Chain-shaker
31	13.50	13.45	0.996	Sunny	Mild Breeze	4	Chain-shaker
34	22.6	28.8	1.274	Rain	Calm	4	Chain-shaker
Averages	12.456	17.533	1.408				
2	4.31	13.13	3.099	Cloudy	Mild Breeze	1	Pusher
4	3.407	5.175	1.519	Sunny	Mild Breeze	1	Pusher
5	2.36	6.64	2.814	Sunny	Mild Breeze	1	Pusher
18	6.96	10.22	1.468	Sunny	Calm	2	Pusher
27	14.50	14.45	0.997	Cloudy	Calm	2	Pusher
29	13.11	27.19	2.074	Cloudy	Mild Breeze	3	Pusher
Averages	7.441	12.803	1.721				
3	23.6	20.5	0.869	Sunny	Calm	1	Pusher-shaker
8	4.5	9.36	2.080	Cloudy	Calm	1	Pusher-shaker
9	11.11	8.74	0.787	Sunny	Mild Breeze	1	Pusher-shaker
10	2.00	9.09	4.545	Cloudy	Windy	1	Pusher-shaker
14	5.26	8.82	1.677	Cloudy	Mild Breeze	1	Pusher-shaker
15	8.45	12.98	1.536	Foggy	Calm	1	Pusher-shaker

(Continued on next page)

Table II. (Continued)

Factory	Trash Determination		Ratio Shipment to Sample	Weather Conditions		General Condition of Cane	Method of Piling Cane
	Sample Results	Shipment Results		A	B		
16	11.4	21.98	1.928	Sunny	Calm	1	Pusher-shaker
20	3.822	8.297	2.171	--	Windy	2	Pusher-shaker
21	6.84	20.23	2.958	Cloudy	Calm	2	Pusher-shaker
22	11.17	20.27	1.815	Cloudy	Mild Breeze	2	Pusher-shaker
24	10.50	23.39	2.228	Rain	Mild Breeze	2	Pusher-shaker
28	9.46	13.24	1.357	Cloudy	Windy	2	Pusher-shaker
30	6.54	12.90	1.972	Rain	Calm	3	Pusher-shaker
35	11.42	29.60	2.592	Cloudy & Foggy	Windy	1-2	Pusher-shaker
Averages	9.005	15.671	1.740				
7	3.92	9.35	2.385	Cloudy	Mild Breeze	1	Other
32	11.46	18.03	1.573	Sunny	Calm	4	Pusher-piler
33	19.52	27.60	1.414	Sunny	Mild Breeze	4	Mule-rake
17	8.05	14.18	1.761	Sunny	Windy	1	?
Averages	10.738	17.290	1.610				
Overall Averages (Cane Piling)	10.020	15.949	1.592				

Table III. Approximate Composition of Trash in Cane Deliveries

Factory	Loose or Attached Tops %	Leaves %	Soil %	Miscl. %	Total %
3	30.95	69.05	--	--	100.00
6	15.20	50.72	34.08	--	100.00
19	38.42* 20.00	17.05	4.42	20.11	100.00
20	30.46	56.57	3.97	--	100.00
22	- 83.34	-	16.66	--	100.00
23	- 76.66	-	23.34	--	100.00
33	30.00	20.00	50.00	--	100.00

*Suckers.

The collection of additional information on the relationship of the trash test to the actual amount of trash in the delivery plus more information of the composition of the trash will be continued during the 1958 season if the factories will agree to cooperate. It should be noted that the labor cost alone for making one of these determinations is about $50.00 per bundle of cane.

To obtain some idea of the cost to the industry of testing cane deliveries for trash, about one half of the factories operating in the state were requested to furnish information on their trash testing operations. The information collected to date is summarized in Table IV. There are rather wide variations both in labor requirements and costs because of the wide range of conditions under which sampling is conducted.

In general it appears that about 0.75 man-hours of labor are expended per trash test at an average cost of around $0.90. The cost on the basis of cane ground is about 2.25 cents. The industry is spending about $125,000 per crop for this task, one of the added costs to the mills of mechanization of our harvesting operations.

Table IV. Comparison of the Cost of Testing for Trash in Cane.

Factory	Man-hours	Cost Per Test	Cost Per Ton Cane Ground	Average No. of Shippers Daily
36	0.83	$0.86	$0.016	31
29	0.16	0.73	0.017	20
23	0.73	0.74	0.028	120
16	0.61	0.61	0.018	225
5	1.13	1.30	0.024	21
37	1.04	1.09	0.037	45
30	1.01	1.08	0.037	20
14	0.35	0.39	0.006	6
9	0.75	1.29	0.029	19
25	0.61	0.67	0.020	35
38	0.74	0.82	0.034	160

PROCESSING OF NEW COMMERCIAL AND UNRELEASED SUGARCANES COMPARISON WITH THE STANDARD COMMERCIAL CANE IN PILOT PLANT CLARIFICATION

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Three of the unreleased sugarcane varieties on secondary test fields have given consistently high yields and have other desirable agronomic characteristics that may warrant the release of one or more of these canes for commercial planting within the next year or two. Evaluation of new canes by milling and processing experiments at the Audubon Factory is now required by the Contact Committee of the American Sugarcane League as part of the data to be considered in determining the suitability of new canes for introduction into the crop. Seed cane of the promising unreleased varieties, C.P. 52/57, C.P. 52/67, and C.P. 52/68, was planted at St. Gabriel plantation, together with comparable quantities of plant cane of standard variety C.P. 44/101 to provide the tonnages required for the pilot plant tests. All of the seed cane was heat-treated to inactivate ratoon-stunting disease virus, and was planted in the Fall of 1956. The American Sugar Cane League undertook the planting, cultivation, and harvesting of the cane which was supervised by Mr. Lloyd Lauden as in previous seasons.

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The stands of stubble cane of varieties C.P. 48/103, C.P. 47/193 N.Co. 310, and standard variety C.P. 44/101 from the 1956 crop at St. Gabriel had been retained to complete the data obtainable by pilot plant processing of these three new commercial canes. Initial tests of these varieties as unreleased canes were made in 1952, and pilot plant experiments have been made with them during each succeeding season. Growers now have quantities of these varieties, and they were removed from St. Gabriel so that both stubble and plant cane of the promising unreleased varieties could be grown for testing in 1958. Additional data obtained after the canes were released are useful for determining more reliably the advantage to growers and processors of increasing the acreage of each of the new commercial canes.

The two-ton samples delivered to the Audubon mill were ground in milling experiments supervised by Professor A. G. Keller under a research contract between the Department of Agriculture and Louisiana State University, results of which will be the subject of a separate report by Mr. C. W. Stewart. Scheduling of the experiments and dates of harvesting and grinding are shown in both Figure 1 and Table I; the schedule was similar to that followed during the 1956 season, and the procedures described in the report of that season's work by the authors (1) were used for clarification of the juices.

Effect of Harvesting Season Weather

The cane at St. Gabriel was subjected to the sequence of adverse weather conditions that affected the commercial crop during the 1957

TABLE I. 1957 VARIETY PROCESSING EXPERIMENTS -- CLARIFICATION CONDITIONS AND PROCESSING RESULTS

Date Harvested	Cane Variety[1]	Run No.	Trash, % of Cane	Dilute Juice pH	Limed Juice pH	Defecated Juice		Apparent Purities of Juice	
						pH	Clarity[2]	Dilute	Defecated
10/16	C.P.44-101S	3	8	5.50	7.40	6.60	26	68.8	71.1
23	"	8	4	5.50	7.30	6.60	41	72.5	75.2
30	"	11	6	5.60	7.25	6.60	44	72.5	74.9
11/6	"	16	4	5.50	7.25	6.55	38	73.4	76.5
		Average	6	5.50	7.30	6.60	37	71.8	74.4
10/14	C.P.47-193S	2	11	5.55	7.35	6.65	28	73.9	74.7
21	"	5	4	5.55	7.30	6.65	38	74.8	76.7
28	"	10	2	5.60	7.20	6.60	48	76.0	78.2
11/4	"	13	3	5.70	7.15	6.60	45	76.1	76.6
		Average	5	5.60	7.25	6.65	40	75.2	76.6
10/14	C.P.48-103S	1	11	5.75	7.25	6.60	25	79.7	80.1
21	"	6	7	5.60	7.10	6.60	33	80.1	83.6
28	"	9	12	5.70	7.15	6.60	33	83.0	83.8
11/4	"	14	4	5.65	7.10	6.60	28	82.8	83.5
		Average	8	5.65	7.15	6.60	29	81.4	82.8
10/16	N.Co. 310S	4	2	5.50	7.40	6.60	25	71.0	74.6
23	"	7	5	5.45	7.35	6.55	29	73.1	76.6
30	"	12	5	5.60	7.25	6.60	29	72.2	73.7
11/6	"	15	4	5.55	7.20	6.55	31	73.9	75.4
		Average	4	5.55	7.30	6.55	29	72.6	75.1

(Continued)

TABLE I. Continued

Date Harvested	Cane Variety[1]	Run No.	Trash, % of Cane	Dilute Juice pH	Limed Juice pH	Defecated Juice pH	Defecated Juice Clarity[2]	Apparent Purities of Juice Dilute	Apparent Purities of Juice Defecated
11/11	C.P.52-57P	18	8	5.50	7.25	6.55	23	70.4	73.0
18	"	21	3	5.60	7.30	6.60	20	73.2	74.3
25	"	25	2	5.50	7.35	6.60	29	73.3	76.2
12/4	"	29	4	5.50	7.35	6.60	33	72.3	75.2
		Average	4	5.50	7.30	6.60	26	72.3	74.7
11/11	C.P.52-67P	17	3	5.35	7.15	6.50	13	72.3	74.3
18	"	22	2	5.55	7.40	6.60	10	79.0	80.7
25	"	26	2	5.65	7.35	6.60	10	77.5	79.7
12/4	"	30	3	5.55	7.35	6.65	19	77.0	79.5
		Average	3	5.55	7.30	6.60	13	76.4	78.6
11/13	C.P.52-68P	20	6	5.60	7.25	6.60	19	75.3	78.4
20	"	23	2	5.50	7.30	6.65	24	79.3	81.7
12/2	"	28	3	5.50	7.35	6.65	20	80.3	80.7
9	"	31	4	5.60	7.35	6.70	24	77.5	78.9
		Average	4	5.55	7.30	6.65	22	78.1	79.9
11/13	C.P.44-101P	19	4	5.60	7.30	6.60	32	72.5	76.7
20	"	24	3	5.55	7.35	6.60	38	74.5	78.2
12/2	"	27	3	5.65	7.30	6.65	37	76.6	79.1
9	"	32	2	5.70	7.35	6.65	37	72.6	76.1
		Average	3	5.65	7.30	6.60	36	74.0	77.5

[1] S - 1st year stubble cane; P - Plant cane

[2] Adjusted to 14 Brix

harvesting season. Growing conditions had been generally favorable throughout the summer, and stands of most of the varieties at St. Gabriel were excellent at the time harvesting began early in October. They were estimated by Mr. Lauden to represent from 25 to 30 tons per acre, with the exception of C.P. 48/103, estimated at 22 tons, and a high yield of N.Co. 310, estimated at 35 tons. A period of unusually frequent and occasionally heavy rainfall began as soon as harvesting was under way and continued during most of the month of October. The quality of the cane samples was better than that of most of the commercial cane harvested during this period when it was frequently impossible to burn trash, and excessive amounts of soil were picked up in mechanical loading, as the cane from St. Gabriel was cut and cleaned by hand. Rainy weather was followed by a freeze on October 27-29, but temperatures at St. Gabriel were below freezing for only a few hours on each of these nights. This location is protected by the river and levees so that the cane for the experimental work escaped the severe damage experienced in some other localities. Recorded temperatures at St. Gabriel did not go below freezing during November, but there were frequent rains during the month and cane continued to grow. The graphs of Figure 1 show that juice purities did not increase as in previous seasons when early frost or cold has been followed by cool, dry weather.

A hard freeze occurred during the morning of December 1 with temperatures below 32° for eight hours; however, all but two of the few remaining samples of cane were harvested within the next three days. The last two samples were delivered to the Audubon mill before the severe freeze on December 11, and they had been affected only slightly by the earlier freeze.

Results of Pilot Plant Clarification

The equipment, procedures, and quantities measured in continuous clarification of juices from the samples of cane have all been described in previous reports (1, 2, 3). Data obtained for comparing the qualities of the juices of the new canes with that of standard C.P. 44/101 are presented in the same form that has been used throughout this research. The juices from the milling experiments were comparable to those obtained in previous seasons despite the unfavorable weather. Only three of the samples of the new commercial varieties contained excessive amounts of trash as a result of rainy weather during October. The plant cane samples of the unreleased varieties were all harvested under more favorable conditions and estimated quantities of trash were as low as in any previous season. Extractions were as good or better than the averages that have been obtained in the past from the three commercial varieties and standard C.P. 44/101 and pol percent cane was above the average of the three preceding years for the stubble cane of these varieties. The unreleased varieties also yielded satisfactory extractions and pol percent cane in the milling experiments from which variety comparisons will be made in the report to be submitted by Mr. Stewart.

Data obtained in the clarification experiments carried out by personnel of the Southern Utilization Research and Development Division are consolidated in the graphs and tables similar to those used in previous reports for comparing the varieties; however, the plant canes of unreleased varieties and of standard C.P. 44/101 comprise a separate group that should not be compared individually with the group of stubble canes of the varieties that have been released. Discussion of the various determinations made in clarifying the juices will deviate from the presentation customarily used in previous years when both plant and stubble cane of all varieties were tested so that each of the two distinct groups of canes may be considered separately.

Tests of Stubble of New Commercial Canes

The four tests made this season of the new commercial varieties C.P. 48/103, C.P. 47/193, N.Co. 310, and standard C.P. 44/101 completed a total of twelve experiments on stubble cane of these varieties since 1954. All of the results will be combined with those of eight experiments during the same period on plant cane of these varieties to arrive at a final evaluation of these canes for clarification. A report summarizing all work done with the new commercial canes is being prepared. The ratings as percentages of the standard in the 1957 experiments differed from the ratings in prior seasons, but the relative evaluations of the new commercial canes will not be altered greatly by combining these data with the larger number of determinations made in earlier clarification tests of both stubble and plant canes. The effect of unfavorable weather, particularly during the harvest, is reflected in the results for this year. The three other seasons, for which data will be combined with those of 1957 in the final ratings, include exceptionally favorable conditions throughout most of 1956, and fairly normal conditions in 1954 and 1955 although purities remained abnormally low during all of the latter season. This report records evaluations for one season only that must be considered together with the ratings assigned in previous years (1, 4, 5).

Purities of the juices of all of the stubble canes, shown in Figure 2, were somewhat lower than in 1956 but all of the new varieties were higher than standard C.P. 44/101. The early maturing variety C.P. 48/103 yielded juice of the highest purity as it has consistently in all prior tests of the canes in this stubble group. The relative ratings of the two other new canes on juice purities were the reverse of those found in 1956 and earlier seasons, C.P. 47/193 yielding juice of somewhat higher purity than N.Co. 310. These two new canes gave juices with purities more nearly equal to that of standard C.P. 44/101. Increases in purity resulting from clarification were of the order observed in earlier experiments, but there has never been any consistent difference between individual varieties in the purity rise effected by the standard, simple lime clarification used in the experiments.

The bar graphs of Figure 3 show the quantities of mud produced, measured as the total weight of material discharged from the clarifier in lbs./T. cane, which is the most important quantity determined in these experiments from an economic standpoint. Quantities of mud produced by clarification of the stubble canes of the new commercial varieties this season were less than those obtained from the same canes in 1956. Differences between varieties were also smaller than during the previous season, but the new commercial canes were all better than the standard C.P. 44/101. The smallest quantity of mud was produced by C.P. 48/103, while N.Co. 310 yielded almost as much clarification mud as the standard. Ratings of this clarification quality as a percentage of the standard, shown in Figure 7, are for the reciprocals of the average quantities of mud obtained. On this basis, C.P. 48/103 was 10% better than C.P. 44/101 this year, when all of the canes gave small quantities of precipitate. The advantage of C.P. 48/103 is even greater when growing and harvesting conditions such as those in 1956 result in juices that produce large quantities of mud. In the tests for that season, C.P. 48/103 rated 30% better than standard (1). While both of the other new canes were somewhat better than standard, C.P. 47/193 was favored particularly by conditions affecting the quantity of mud obtained from the juices this season, and its relative rating was better than that of the stubble cane of N.Co. 310. This is a reversal of the relative ratings assigned in most of the previous experiments with both stubble and plant cane of these varieties.

The total quantity of mud, including the weight of sugars and other soluble solids of the juice removed with the precipitate, determines the rate at which processing can be carried out with a given clarifier capacity. The quantities produced in individual tests are shown as the wet mud weight in Table II. This table also shows the individual and average actual weights of dry solids per ton of cane removed in the corresponding quantities of total clarifier discharge. This weight of dry solids is more comparable to the amount of filtered and washed mud eliminated in factory operation than the total weight of wet mud; however, it is the total quantity of precipitate and juice in wet mud, rather than the insoluble solids content, that limits the practical rate of clarification. The densities to which the precipitates can be thickened in the clarifier vary within wide limits, so that the weight of insoluble dry solids eliminated is not related consistently to the quantity of total mud that must be discharged. The weights of dry solids are corrected by deducting the weights of field soil in excess of 1 lb. per ton of cane, which is considered to be the amount allowable in juice of uniformly clean cane. The actual weight of field soil in each raw juice sample is approximated from the mineral content of the total suspended solids collected by filtering samples of the mixed juice and determination of the ash content of the washed solids.

Average amounts of lime in lbs./T cane used in clarifying the juices of the stubble canes are shown graphically in Figure 4. The same grade of high purity, reactive lime was used throughout the season, and continuous liming was controlled automatically to produce clarified juice at pH 6.6 ± 0.05 in all but two experiments. Amounts of lime consumed by the stubble cane juices were not directly proportional to the weights of either the whole, wet mud or the total dry solids

TABLE II. 1957 VARIETY PROCESSING EXPERIMENTS -- LIME REQUIREMENTS AND MUD EVALUATIONS

Cane Variety[1]	Run No.	Lime Required, Lbs./T.Cane	Dry Solids, % of Mud Weight	Mud Wt., Lbs./T.Cane Wet	Mud Wt., Lbs./T.Cane Dry Solids Actual	Mud Wt., Lbs./T.Cane Dry Solids Adjusted[2]	Dry Solids Analyses Weight % Mineral	Dry Solids Analyses Weight % Organic	Settling % Mud Vol. in 60 min.
C.P.44-101S	3	1.41	7.95	136	10.81	6.27	61.1	38.9	14.5
"	8	1.64	10.47	119	12.46	7.11	62.3	37.7	15.4
"	11	1.44	7.41	114	8.45	6.51	48.9	51.1	15.0
"	16	1.42	5.21	136	7.09	6.71	35.2	64.8	10.5
	Average	1.48	7.76	126	9.70	6.65	51.9	48.1	13.8
C.P.47-193S	2	1.33	5.77	112	6.46	6.06	62.6	37.4	9.0
"	5	1.47	6.64	118	7.84	6.90	39.0	61.0	19.8
"	10	1.38	6.34	126	7.99	7.17	35.6	64.4	12.5
"	13	1.40	6.18	115	7.11	6.14	35.0	65.0	15.4
	Average	1.40	6.23	118	7.35	6.57	43.0	57.0	14.2
C.P.48-103S	1	1.06	4.88	134	6.54	6.02	33.0	67.0	10.8
"	6	1.16	8.61	110	9.47	6.41	48.6	51.4	10.9
"	9	0.99	8.34	108	9.01	6.75	40.6	59.4	14.5
"	14	1.09	6.00	102	6.12	5.36	31.1	68.9	9.4
	Average	1.08	6.96	114	7.78	6.14	38.3	61.7	11.4
N.Co. 310S	4	1.33	12.59	136	17.12	7.30	65.3	34.7	16.8
"	7	1.22	9.82	109	10.70	6.43	54.3	45.7	14.9
"	12	1.31	6.05	110	6.66	6.20	31.6	68.4	11.8
"	15	1.18	5.15	134	6.90	6.65	30.1	69.9	13.7
	Average	1.26	8.40	122	10.34	6.64	45.3	54.7	14.3

(Continued)

TABLE II. Continued

Cane Variety[1]	Run No.	Lime Required, Lbs./T. Cane	Dry Solids, % of Mud Weight	Mud Wt., Lbs./T.Cane Wet	Mud Wt., Lbs./T.Cane Dry Solids Actual	Mud Wt., Lbs./T.Cane Dry Solids Adjusted[2]	Dry Solids Analyses Weight % Mineral	Dry Solids Analyses Weight % Organic	Settling % Mud Vol. in 60 min.
C.P.52-57P	18	1.24	7.49	94	7.04	5.97	41.3	58.7	8.6
"	21	1.32	7.94	102	8.10	6.15	45.9	54.1	10.2
"	25	1.38	7.81	109	8.51	6.20	46.4	53.6	12.1
"	29	1.42	9.83	109	10.71	6.72	53.2	46.8	14.7
	Average	1.34	8.27	104	8.59	6.26	46.7	53.3	11.4
C.P.52-67P	17	1.42	5.00	142	7.10	6.26	32.9	67.1	11.5
"	22	1.42	7.89	122	9.63	7.27	43.9	56.1	14,2
"	26	1.11	9.63	106	10.21	6.46	49.5	50.5	14.4
"	30	1.15	8.08	106	8.56	6.05	47.0	53.0	12.7
	Average	1.28	7.65	119	8.88	6.51	43.3	56.7	13.2
C.P.52-68P	20	1.10	10.00	113	11.30	5.65	60.5	39.5	12.0
"	23	1.25	7.84	109	8.55	6.24	48.1	51.9	12.3
"	28	1.23	7.96	101	8.04	6.16	40.3	59.7	13.0
"	31	1.29	7.96	123	9.79	6.87	46.9	53.1	14.4
	Average	1.22	8.44	112	9.42	6.23	49.0	51.0	12.9
C.P.44-101P	19	1.27	8.93	108	9.64	5.65	59.1	40.9	11.2
"	24	1.37	9.29	108	10.03	5.98	58.9	41.1	11.4
"	27	1.30	8.56	103	8.82	6.33	48.1	51.9	11.9
"	32	1.33	6.04	111	6.70	5.78	39.9	60.1	12.1
	Average	1.32	8.20	108	8.80	5.94	51.5	48.5	11.6

1/ S - 1st year stubble cane; P - plant cane.

2/ Adjusted to 1.0 lb. suspended field soil per ton cane in dulute raw juice.

precipitated, but they were in the same relative order. The quantities of mud precipitated were also less this year than in 1956, and about 20-25% less lime was required on the average for the standard and C.P. 47/193 and N.Co. 310; C.P. 48/103 which produces the least mud, required only 62% as much lime per ton of cane this year as was used in 1956 to clarify stubble cane juices of this variety.

Average clarities of the clarified juices of the new commercial canes and standard C.P. 44/101 stubble cane, shown in Figure 5, were not as high as those produced by clarification of these canes during previous seasons. It has been observed throughout this work that poorer clarities are generally obtained for juices that yield smaller quantities of precipitate in clarification. The higher clarity of C.P. 47/193 with respect to the standard is consistent with the clarity ratings of this variety in all of the previous seasons during which it has been tested. It yielded juice of better clarity, even though it produced somewhat less mud than standard C.P. 44/101 this year. Variety C.P. 48/103 stubble cane did not give as good clarity this season as it has in the past. The clarity of the juice of N.Co. 310 was as good as that of C.P. 48/103, but both were 7% lower in clarity than juice of standard C.P. 44/101.

The composite data presented in Figure 6 afford a convenient comparison of the stubble canes of the new varieties with one another and with the stubble of standard C.P. 44/101 with respect to all quantities determined in the clarification experiments. For comparison of stubble cane only during a season when conditions were less favorable than usual, consideration of all of the results places C.P. 48/103 first, as having the most desirable qualities for processing by simple clarification. Its superiority to the other new commercial canes and to the standard is not as great as that determined in previous seasons when conditions were more favorable. The rating of C.P. 47/193 on these stubble cane tests alone would be much better than it has been on the basis of prior experiments with both plant and stubble cane. Its processing qualities are substantially equal to those of N.Co. 310, and both of these new canes are better than the standard although the margin of superiority is small. The choice among these new canes will depend upon the importance attached to ease of clarification at maximum rates with small quantities of mud to be filtered and of filtrate to be recycled, or to the production of juices of the highest clarity. Factories with limited clarifier capacity must consider the increased cost of reducing the rate of grinding and processing to handle large quantities of clarifier discharge, and would find it more profitable to process C.P. 48/103. Where clarifier capacity is ample, and juices of high clarity are desired, this can be attained more consistently by processing C.P. 47/193. Processing of N.Co. 310 should be possible at about the same rate as standard C.P. 44/101, but the juice clarity will not be as good as that of standard cane juice.

Raw juice purities are tabulted in Figure 6 because they affect results obtained in clarification, although this is a quality of the cane as received and is not itself a processing characteristic. The high purity of the juice of C.P. 48/103 increases its superiority over the other canes when considered together with its good processing qualities. Comparison of stubble cane only, harvested early in the season, gives a higher relative purity rating for the early maturing C.P. 48/103 than it received in other years when both stubble and plant cane were tested throughout the season. The data shown quantitatively in Figure 6 are represented as percentages of the standard C.P. 44/101 in the conventional graphs of Figure 7.

Tests of Plant Cane of Unreleased Varieties

It must be emphasized that any comparisons of the unreleased canes based upon tests of plant cane only for one season, when unusual conditions prevailed during the harvest, are preliminary. Data obtained this year in clarification of the juices of these canes are merely an indication of what may be expected of the new varieties, and future experiments with both plant and stubble cane may reverse their relative standings with respect to the standard plant cane. The average quantities determined in the clarification of only four samples of each of the juices have little or no statistical significance. Additional plantings of varieties C.P. 52/57, C.P. 52/67, and C.P. 52/68 were made in the Fall of 1957 to provide plant cane for experiments in 1958, when stubble cane of these varieties will also be tested. Twelve to sixteen experiments with each variety, including preferably an equal number of plant and stubble cane tests, are required for statistically significant and reliable determinations of the quantities measured by clarification in the pilot plant.

The plant cane samples of unreleased varieties yielded juices with purities more nearly equal to that of the plant cane juice of C.P. 44/101, as shown in Figure 2. A lower purity was found for the average of the juices of C.P. 52/57, while C.P. 52/67 and C.P. 52/68 gave somewhat higher purities than the standard plant cane. The quantitative differences in purity of 1.7% below to 4.1% above the average 74.0% purity of the standard were not large enough to have an appreciable effect upon results obtained in clarification and the juices were comparable in quality.

The experiments with juices of C.P. 44/101 standard plant cane produced smaller quantities of clarification precipitate than usual (1, 2), and it may be assumed that the quantities of mud produced by the new canes this season are also low. They might be expected to yield larger amounts of mud when they are tested after more normal growing and harvesting conditions. Only one of the unreleased canes, C.P. 52/57, produced less mud than the standard, but its advantage of only 4% is not significant. The inferiority of C.P. 52/68 was only 4% and is not significant, but the production of almost 10% more mud from juices of C.P. 52/67 indicates that it may prove to be inferior with respect to the rate at which its juices can be clarified. Excessive mud production by juices of this cane may not be confirmed after more thorough testing, as the two experiments made later in the season both yielded only 106 pounds per ton of clarifier discharge, less than the average obtained from the standard cane juice. The average result for C.P. 52/67 was increased by the two experiments made with this cane in mid-November in which 122 and 142 pounds of mud were obtained per ton of cane, as shown in the data for individual tests in Table II.

The quantities of lime required for clarification of the plant cane juices, shown in Figure 4 as lbs./T. cane, were neither proportional nor directly related to the quantities of precipitate discharged in clarifying these juices. The juice of C.P. 52/68 produced somewhat more mud than C.P. 44/101, but required less lime than the standard plant cane juice. The amounts of lime used were small for plant cane juices including that of the standard C.P. 44/101, as plant cane juices have always consumed considerably more lime than the stubble cane juices of the varieties that have been tested in the past.

Clarities of the clarified juices of the unreleased varieties can be compared with that of the plant cane juice of C.P. 44/101 by reference to Figure 5, which shows that all of them produced juices of poorer clarity than the standard. Plant cane juices have generally, although not invariably, had better clarities than the stubble cane juices of the varieties for which the two kinds of cane have been compared in previous seasons; however, the clarities obtained for these unreleased varieties as plant cane are lower than those of the juices of stubble of the commercial canes tested this year. Clarities in general were lower this season than in the tests made during any previous crop. Consistently low clarities of 10-19 Luximeter units were obtained in the individual tests of C.P. 52/67 for the low average clarity of 13 units, as shown in Table I. This poor clarity is not compensated by the advantage of low mud production, as C.P. 52/67 produced the largest quantity of mud of any of the unreleased canes, and was poorer than the standard in this respect also.

A composite presentation of the averages of all quantitative determinations made on juices of the unreleased varieties is given in Figure 6, and the relative ratings obtained for these canes are shown as percentages of the standard cane by the graphs of Figure 7. The results reported for these experiments must be considered with the reservation emphasized before that they are preliminary, and are very likely to be altered significantly by the additional tests that are scheduled to be completed before a decision is reached as to releasing one or more of these new canes.

A complete record of all of the data obtained in the 32 pilot plant processing experiments is given in Tables I and II for both the unreleased and the new commercial canes. Results of laboratory measurements of the rate of settling of mud from all the juices are tabulated in the last column of Table II. These tests were carried out with samples of limed and heated juice drawn at the clarifier inlet, which were allowed to settle in a cylinder placed in an insulated cabinet to minimize convection. The cylinder design and procedure were improved this year, but similar laboratory settling data have been obtained during several previous seasons. The percentages of the total volume occupied by the precipitate after settling for 60 minutes do not show any relationship to the weights of mud per ton of cane discharged from the pilot plant clarifier under conditions of continuous clarification in motion comparable to commercial clarification. A theoretical equation has been published recently (6) and a laboratory clarification and settling test has been described for determining the relative rates of settling of precipitates from cane juices as a measure of their suitability for clarification.

The action of gravity settling from quiescent juice in the cylinder test is not the same as that of settling in motion and thickening in the clarifier. Lack of correlation between the results of the two different types of settling shown in Table II indicates that conditions in the clarifier relative to gravity settling are more effective for thickening some precipitates and less so for others. This can be accounted for by variations of the density, size, and shape of the precipitated flocs, which have been investigated most recently by Bennett (7). Data accumulated for 5 years from these settling tests and the corresponding pilot plant experiments will be analyzed to determine whether any correlation can be developed. We do not know of any other investigations in which quantitative data have been obtained from controlled clarification on a pilot plant scale for comparison with laboratory settling tests that have been proposed for use in processing research or control of factory clarifier operation.

ACKNOWLEDGMENT

We are sincerely pleased to credit the effective cooperation of the American Sugar Cane League during this season, as in past years, for much of the success of this research program. We are particularly indebted to the Industrial Committee of the League for counsel and assistance in planning the experiments, and to Mr. Lloyd L. Lauden, the League's Field Representative, for untiring attention to details of production of the cane for our use. The experiments would not be possible without the genuine interest and care of staff and personnel at St. Gabriel Plantation who planted, cultivated, and harvested the canes as required for the scheduled tests, in spite of unfavorable weather during the harvest season. We are also grateful for unstinted cooperation of Professor A. G. Keller and his staff at Louisiana State University regarding phases of these experiments related to their program of testing the canes for milling qualities under contract with the U. S. Department of Agriculture.

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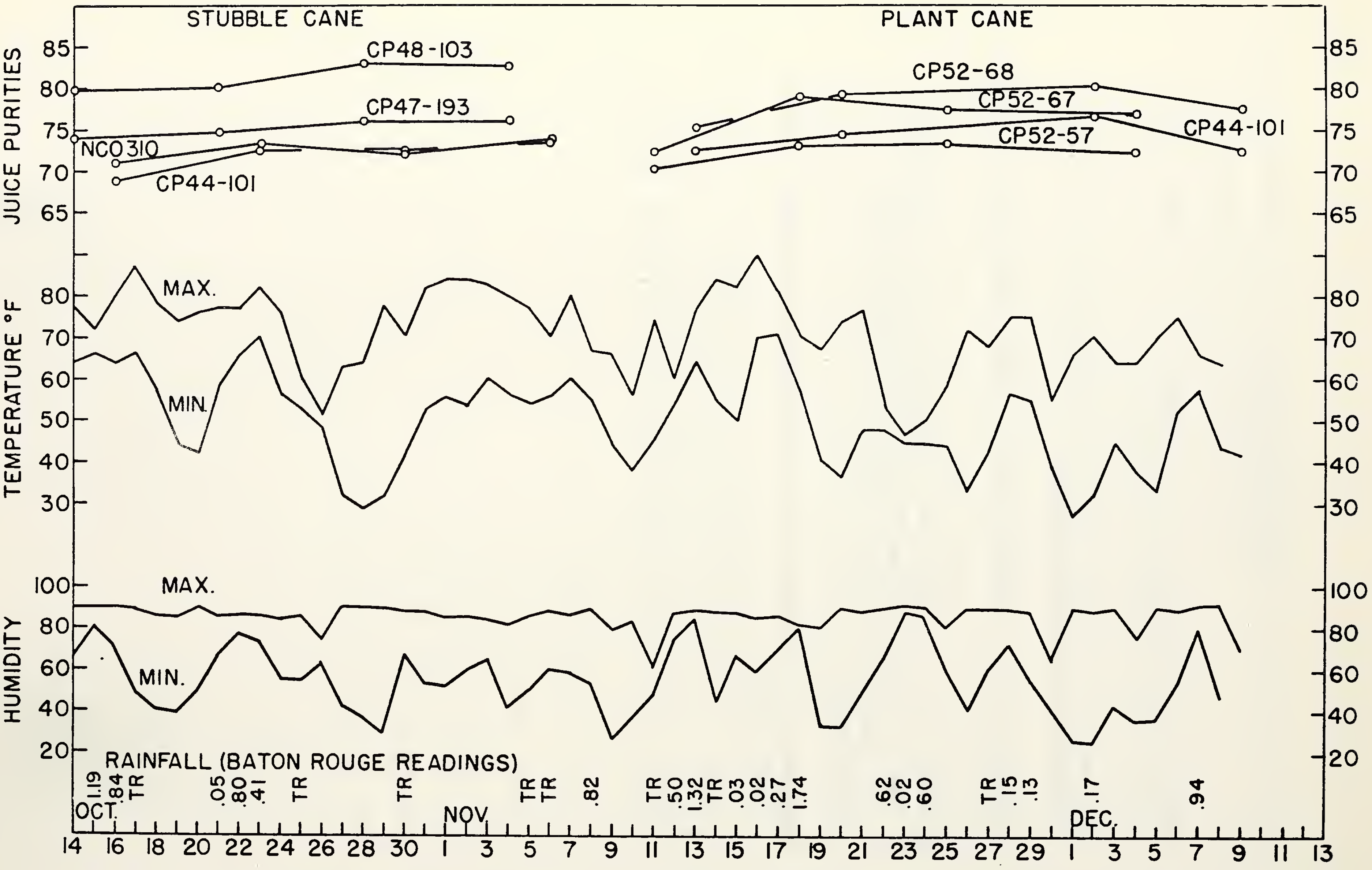

FIG. I-WEATHER CONDITIONS AND JUICE PURITY CHANGES DURING 1957 GRINDING SEASON

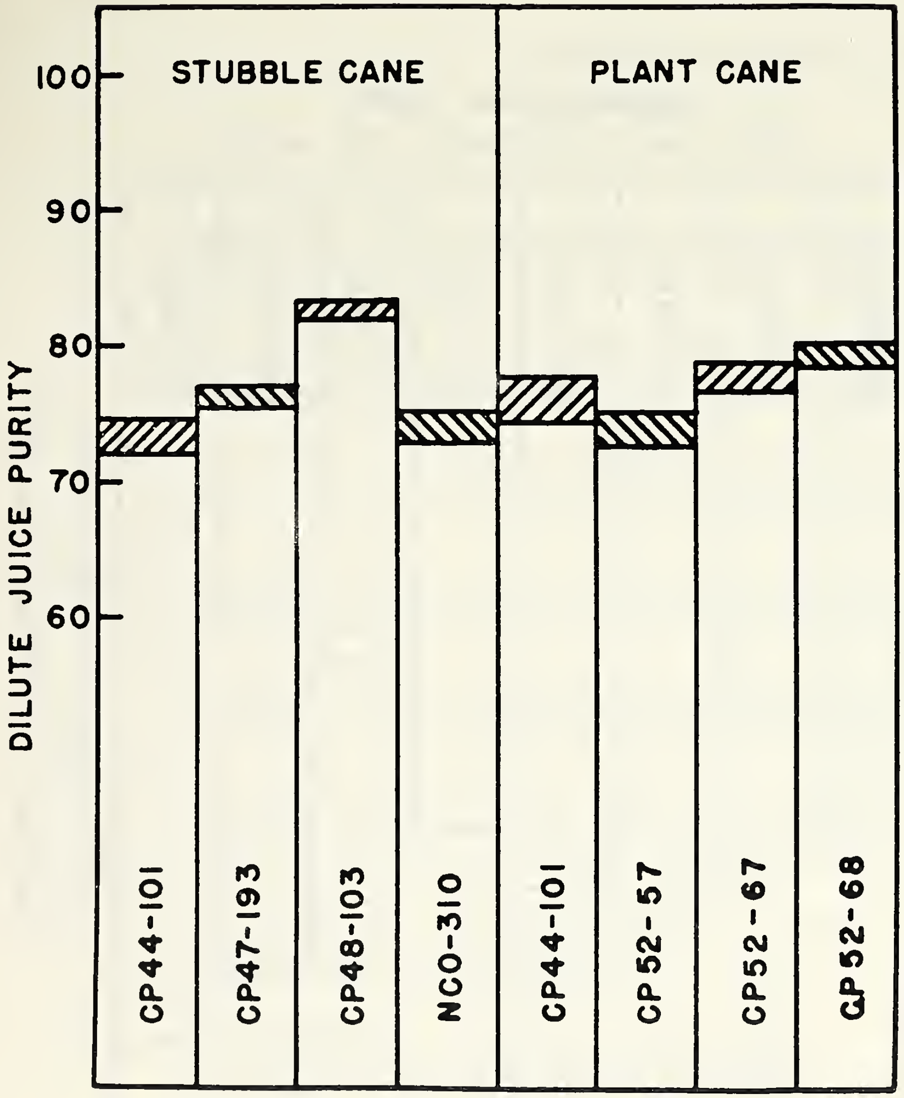

FIG.2 1957 VARIETY COMPARISON
DILUTE JUICE PURITY
(PURITY RISE IN SHADED AREAS)

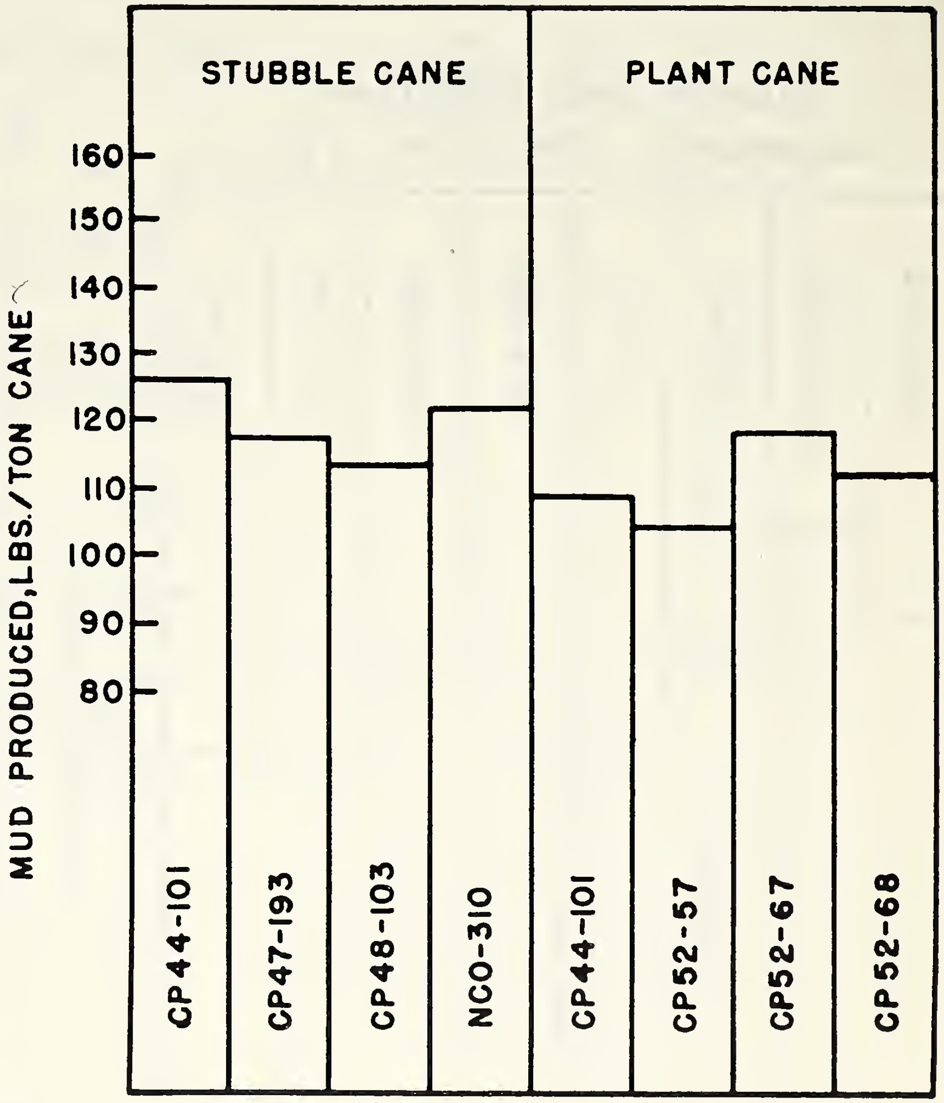

FIG.3 1957 VARIETY COMPARISON
MUD PRODUCTION

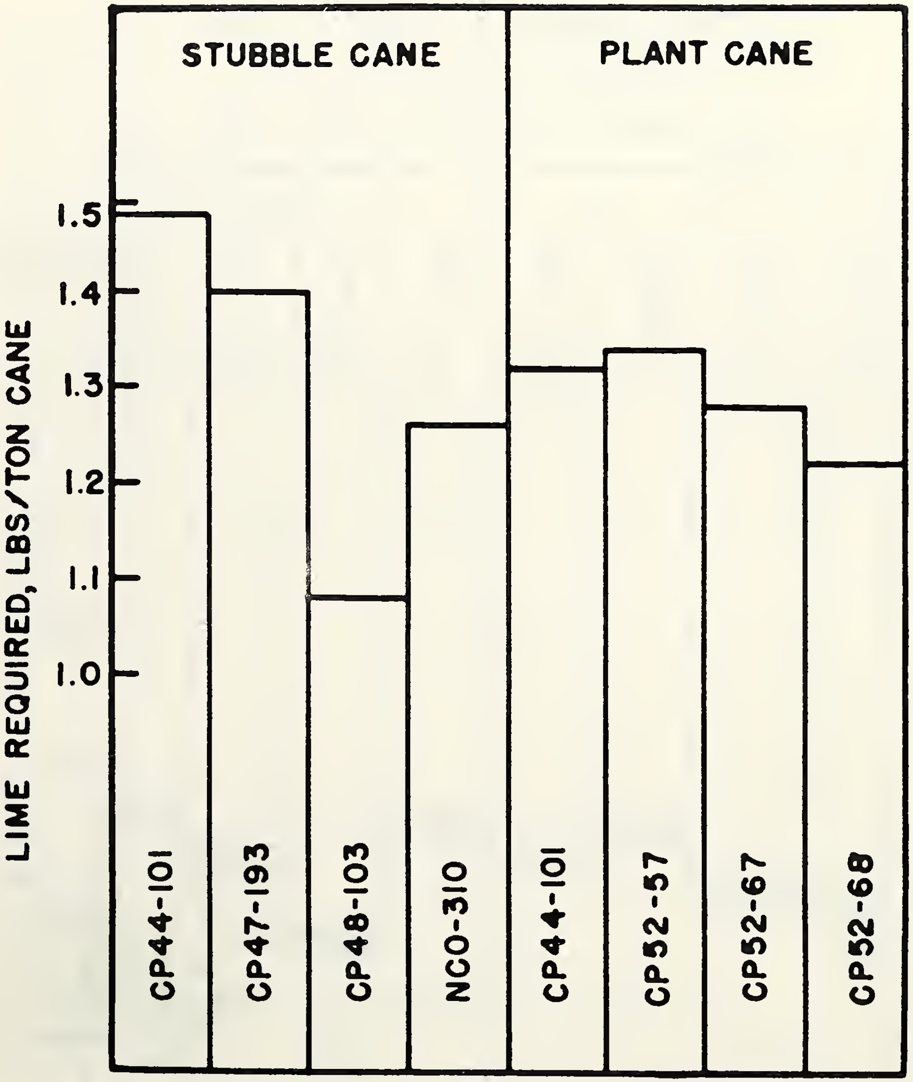

FIG.4 1957 VARIETY COMPARISON
LIME REQUIREMENT

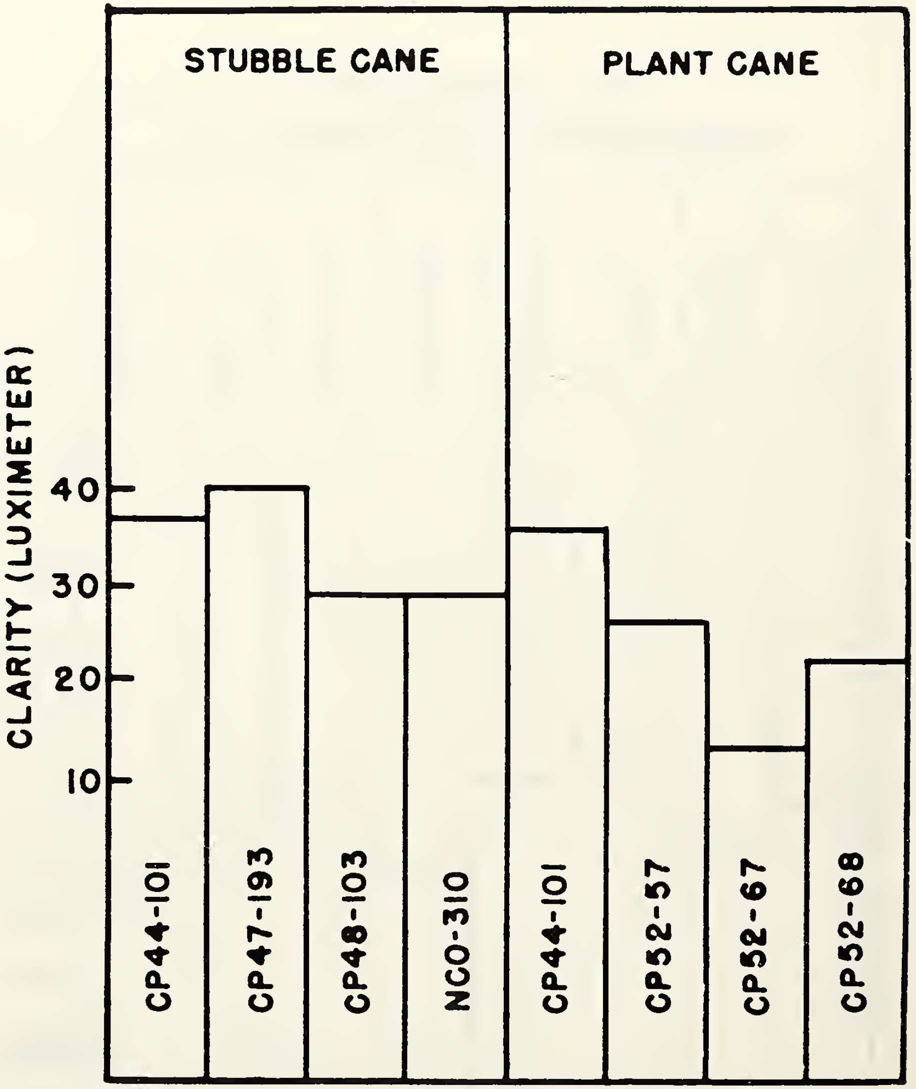

FIG.5 1957 VARIETY COMPARISON
DEFECATED JUICE CLARITY

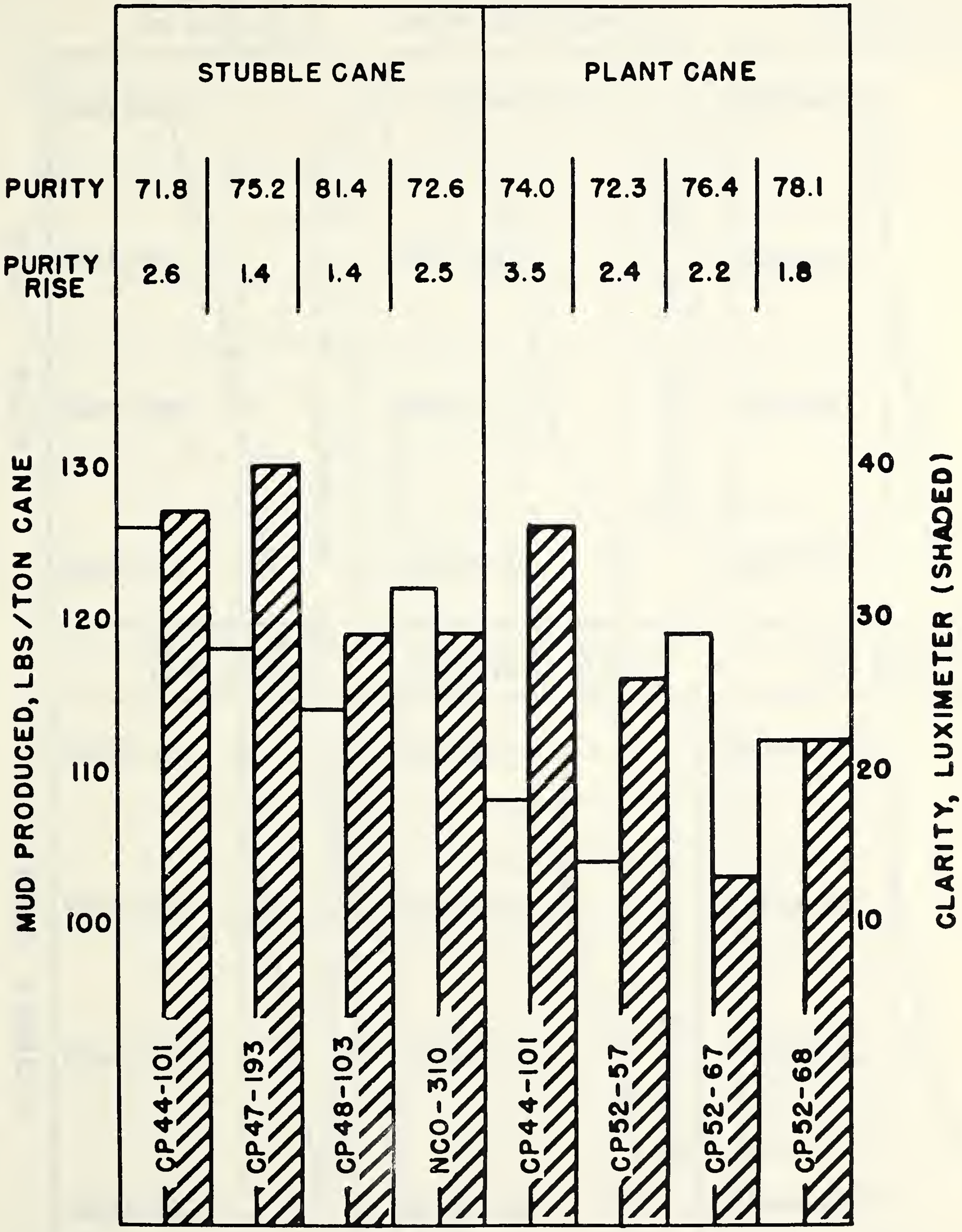

FIG. 6, 1957 SUMMARY OF VARIETY PROCESSING COMPARISONS

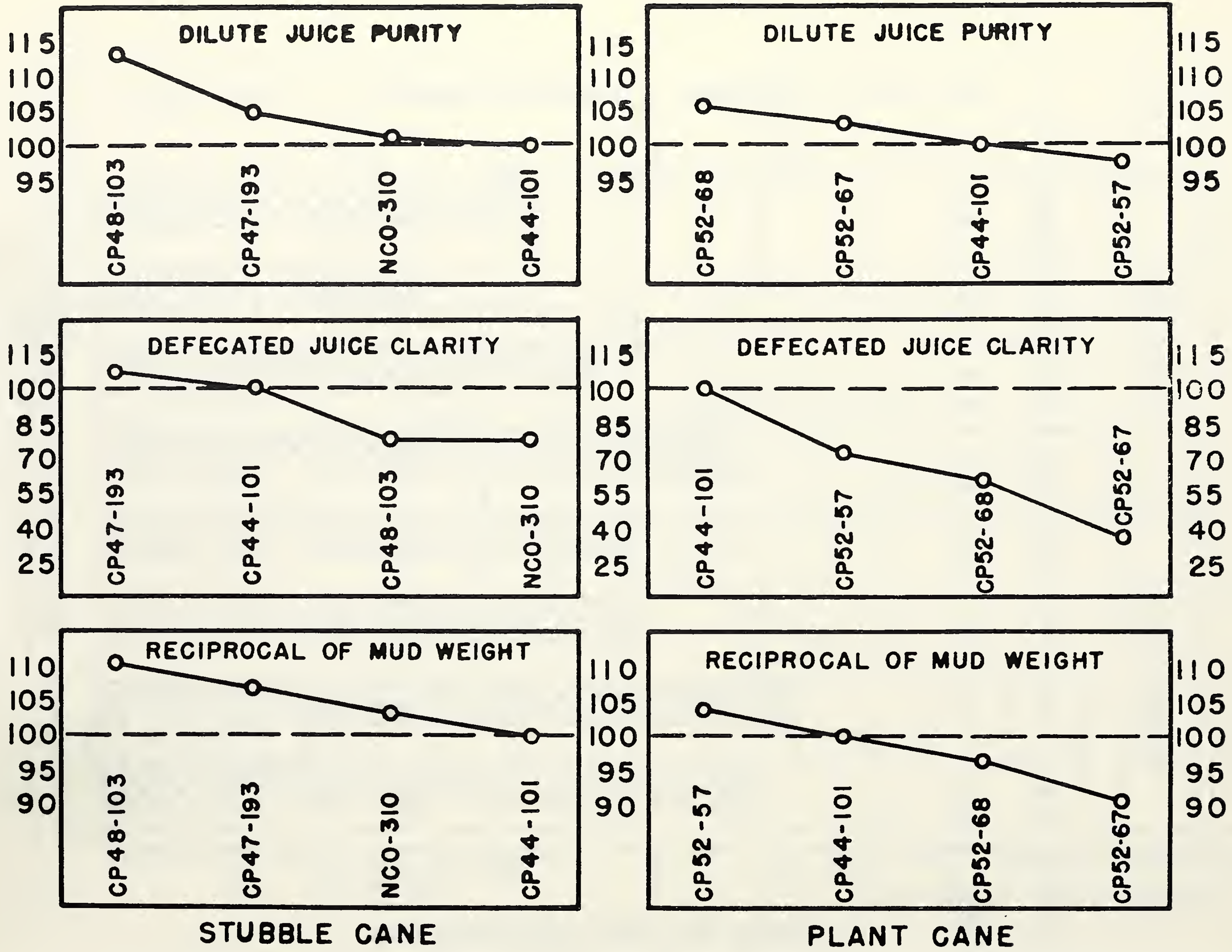

FIG. 7, 1957 VARIETY COMPARISONS (CP44-101 AS STANDARD)
]

SAMPLING AND TESTING OF SUGAR CANE

Eugene H. Graugnard

This paper is not intended to be a condemnation of the present methods of sampling and testing, but more in the light of constructive criticism with the hope that a more equitable procedure may result. The discussion that follows is not technical due to my inability to digest the highly technical phases and is more of a layman view of the problem facing both the producers of sugar cane and the processors who convert the cane into sugar, molasses, etc.

The usual statement that is produced when this subject is mentioned is "The division of proceeds between grower and processor is too controversal and too explosive to discuss." This attitude is regretable since the gross dollars to be divided are present in the cane as it stands in the field. The management of the cane from the fields through the factory determines the percent of the potential sugar which can be recovered. The items of utmost importance in our sugar industry are sugar produced per acre and sugar produced per gross ton of cane.

The greatest weakness of the present system of sampling and testing is that it is beset with human element, factors, averaging, equalizing and accepted constants which tend to make it difficult for the producer of the raw material to improve the product delivered and to hope to be rewarded accordingly. The system presently used was at one time the best available and to adjust for the constantly changing nature of our industry, additional factors were introduced. It is now the time to take a fresh look and attempt a new start.

First, we will take a journey along the road of the present method of sampling and testing as practiced by most processors and covered by the regulations of the sugar section.

The selection of the sample is on a routine basis, or in some cases may be randomized, but still under the influence of human nature. This is further complicated by the fact that, in far too many cases, the manual selection and cleaning of the sample is identified by the grower's name. Likewise, in some cases it has been possible for the grower to anticipate with some degree of accuracy the load from which the sample is to be taken. Any system in which the selection of the sample can be influenced by either party, or its employees, is not conducive to maximum accuracy. The sample for sucrose analysis is ground in a hand mill which results have to be adjusted by a Brix and sucrose correction factor ranging in percent anywhere from the 80's to the 90's. While this wide difference in factors is understandable, it is psychologically difficult to accept, since it is negative. Much could be written about the hand mill and efforts that have been made to improve its performance. This accounts for the cases where high factors are in use, as the hand mill extraction more closely approaches that of the mill tandem with maceration. The hand mill yields a sample of juice of higher quality and which is not in a direct proportion to the normal juice with the advant of changes in agricultural management practices and improved mill extraction. It is difficult and at time impossible to arrive at a dry milling factor which when completed is not questionable in accuracy. The hand mill juice sample in most cases represents more closely the crusher juice or first mill juice sample and the correction factors do not prevent the following, "producers of high quality fresh cane subsidize producers of low quality stale cane." The processor does not enter in this inequity since under the formula the analyses of the mixed juice in relation to the average of grower's sample analyses is used to compute the factor. Is this conducive to improved performance? Is it too much to expect that a product of similar quality should have the same value to the grower regardless where processed?

There ia another area where there is an inequity between grower and processor which is fiber content, juice quantity or millability which will be discussed later.

The juice samples, in most cases, yet with the growers name attached, are analyzed. The laboratory personnel cannot be as impersonal with the samples if identified by names as with numbers.

In regard to the laboratory and its resulting analyses which are highly technical the following questions are posed.

Why do some factories use the simple average and others the weighted average on grower's samples to arrive at the factors? Are they both equally accurate? Why do some factories use time and others use vacuum to remove air from graduated cylinders prior to taking Brix reading? Are both equally accurate?

If given two tanks of juice, as received from the hand mill or the mill tandem, tank A and tank B of equal quantity and quality (Brix, sucrose and purity) and processed in the same boiling house of the same efficiency, will equal amounts of sugar be produced? If the answer to the above is negative then the qualitative analysis needs additional research since this could adversely effect both grower and processors at varying times.

At this point the question arises, "Is there anything good about the present method of sampling and testing?" There are many bright sides toward improving the system such as research work done and being done by the L.S.U. Audubon Sugar School, U.S.D.A. Research Station in Houma and the Southern Regional Laboratory in New Orleans, in addition to which the Audubon Sugar Factory is working on a new approach to the sampling and testing procedure.

The following is a suggested possibility of an improved method of sampling and testing. Some points to be listed are presently possible, others represent the ideal and still others need research to be proven.

The evolution of this proposal is the result of a challenge by the statement, "if our present method of sampling is so bad can you suggest anything better." The following may or may not be much better but it is different. The material presented represents a statement made by growers and processors alike, discussions, published reports or any suggestions gathered from any source no matter how technical or humble.

The first step is that the identification of either trash or sucrose samples must be impersonal. It is here suggested that a method of mechanical chance selection be employed to direct when and where the sample is to be selected. As a possibility, a caged group of numbered balls as used in bingo (if legalized by the legislature) would pinpoint the load to be sampled as it crosses the scale. This would put both parties on a pure chance as to selection. This sample would be identified by serial number all through its route and would be reunited with the grower at the accounting office after coming from its various analytical processes. In this manner no one can claim bias since "The analysis is no better than the sample."*

To account for the most important inequity in our present system a more radical departure is offered. This suggestion is not meant to minimize the present suggested approaches to the problem but to supplement these approaches since it is fully realized that it is easier to suggest a solution than to accomplish it.

The point in case is well covered in publications of work done at the Audubon Sugar Factory** and USDA*** Station in Houma on that there are variable sugar producing potential of different varieties and rotations of cane, i.e., plant, 1st, 2nd, 3rd stubble. "Results of tests show that commercial varieties in Louisiana differ by as much as 8% in theoretical yield of sugar per ton with the same sucrose and purity analyses of crusher juice because of differences in juice extraction and in purity drop with complete milling."****

It is proposed that a device be used to take a gross sample of cane from the grower's load by mechanical grab at which time a gross weight is recorded. This gross sample is to be processed in a device that will be in one pass without maceration equal or more nearly approach the present day mill tandem extraction. The device that gives promise to do this is a type of screw extractor similar to which has been in experimental use at a Louisiana factory for the past few years. The juice will then be weighed and a sample of the juice qualitatively analyzed.

If this were developed and made practical consider these points. There would be no trash analysis as such since we parallel the operation of the milling department of the factory which receives gross cane and produces a certain quantity of a certain quality juice which is the starting point of boiling house factory control. The muds, impurities, sap from the leaves or tops, etc. would be present in the grower's sample in the same proportion as in the normal mill juice. The absorption and retention of sucrose in dry leaves, shuck and bagasse would also maintain its relationship. In its most simple analysis the milling department can make or lose money mainly by its extraction efficiency or the quantity and quality of juice extracted from a given gross weight of cane. In regard to improve agricultural management practices we have the following effect of producing and managing a product that would yield more potential sugar per acre and get paid accordingly. In its simplest form assuming a fixed purity - juice X sucrose equal sugar. In this respect two samples of identical sucrose with different quantities of juice per ton will yield different quantities of sugar.

How important is this variability of varieties in a monetary sense? Published in 1957 - SUMMARY OF SUGAR CANE VARIETY INFORMATION IN LA.

Period 1952-56

Variety	Millability	Year	Raw Sugar Price per Ton
C.P. 44-101	1.00	1951	5.822
Co. 290	1.04	1952	6.209
C.P. 36-105	.96	1953	6.093
C.P. 43-47	.98	1954	5.959
C.P. 44-155	1.00	1955	5.893
C.P. 48-103	1.02	1956	6.1783
N.Co. 310	1.00	1957	6.1287
Avg.	1.00		6.0404
High 1.04% Low 96%		High 6.209 Low 5.822	
Percent difference of average			
High 4% Low 4%		High 2.80% Low 3.44%	

To point out this variability compare C.P. 36-105 with either 44-101 or N.Co. 310 in which case there is a 4% difference in millability resulting in a gain or loss of approximately 24.5 cents per ton of standard cane for the grower or processor as the case may be.

The variability of sugar recovery in our recent commercial varieties approximates the average variability of price of raw sugar. This has an effect on the returns to the grower and processor as well. An accurate method with proper relationships would encourage delivery of a product of higher quality since the compensation would be monetary and would be in direct relation to the sugar producing potential of the sample. This would encourage production and management practices which would deliver to the mill more pounds of sugar per acre and on which the mill would be able to recover more pounds of sugar per ton.

In regard to the qualitative analysis of the juice samples we take a second look at our two tanks of juice of identical quality as determined under our present system. It is here urged that research be instituted that would search out possible analytical procedures that may more closely indicate the sugar producing potential of a particular juice sample. As a starting point it may be possible to vacuum filter the juice sample before reading Brix, and by weight of the filter paper on which is deposited the similar relative impurities removed by clarification and filtration in the boiling house, we may have paralleled boiling house operation and are in a position to test clarified juice and account for the removed impurities.

At this point it may be felt that no discussion has been given to the division of proceeds of a ton of sugar cane. This will be left to persons far more qualified in this field since the purpose of this presentation is to arrive at a more equitable method of sampling and testing so as to increase the total sugar produced and processed per acre and to remunerate parties involved accordingly.

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FOREWORD

This is part B of the seventh volume of proceedings of the Society which have been published since its founding in 1938.

The first volume published in 1941 included papers presented during 1938, 1939, and 1940. Mr. Walter Godchaux, Jr., the then Secretary-Treasurer, edited that edition.

The second volume published in 1946 included papers presented during 1941-1945 inclusive. Dr. E. V. Abbott, Secretary-Treasurer, edited that edition.

The third volume published in 1953 included papers presented during 1946-1950 inclusive. A fourth volume was published in 1955 and presented papers for the years 1950 through 1953. Volume five contains papers for the years 1954 and 1955. The sixth volume included papers presented during 1956. The third through sixth volumes were edited by Dr. Arthur G. Keller.

This volume 7B includes papers for the years 1959 and 1960 and has been compiled by the writer.

Denver T. Loupe

Secretary-Treasurer

March 1963

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SUGARCANE BREEDING AND SELECTION AT LOUISIANA STATE UNIVERSITY

R. D. Breaux, E. Paliatseas, Louis Anzalone, S. J. P. Chilton

1959

INTRODUCTION

The first seedlings of sugarcane were grown by the Department of Plant Pathology in 1949. This followed a decision by the three organizations concerned (The American Sugarcane League, The United States Department of Agriculture, and the Louisiana Agricultural Experiment Station) to expand the existing breeding program. Since that time Louisiana produced seed has been included in the program. The first tangible results of public benefit were realized from the program in 1958 with the release of the variety C.P. 52-68. However, this paper will be confined primarily to methods employed in producing seed and handling seedlings in the greenhouse and in the field rather than a discussion of results or of the relative effectiveness of different methods of securing or selecting new varieties of sugarcane.

Producing the Seed

Although commercial production of sugarcane has depended for centuries upon vegetative reproduction, and must continue to do so, this is not the only method of producing cane plants. For a long while it was generally believed that cane would not produce seed that would germinate and grow. The first serious attempt to grow and test cane seedlings were made between the years 1887-89 in Java and Barbados.

Prior to this time attempts to improve existing varieties depended upon mutation and progress was slow. The production of new cane varieties in every cane growing country has since been based upon sexual reproduction - that is hybridization and selection.

As in every breeding program of crop plants the work begins with flowering and seed production. Although floral initiation occurs most years, flowering of sugarcane in Louisiana is occasional, depending on environmental conditions. Floral initiation is dependent primarily on day length but other factors are probably involved. Seed production in Louisiana is based primarily upon both experimentally induced (by control of the photoperiod) flowering at Baton Rouge and naturally induced flowering at Grand Isle.

The sugarcane inflorescense, as a general rule, is a panicle with spikelets carrying perfect florets. However, due to environmental or genetic reasons some varieties produce tassels with sterile pollen. Sugarcane breeders the world over use the term "male" to refer to tassels that produce pollen and "female" to those tassels that do not produce pollen. Once initiated, sugarcane takes 4 to 8 weeks for tassel emergence. If the temperature is above 70°F pollen begins to shed in five to ten days.

Sugarcane is a highly heterozygous plant. That is, it does not breed true and each resulting seedling of a cross is essentially a different variety. In Louisiana so called indoor or greenhouse crossing is used. Male and female tassels are tied together in the greenhouse with the male tassel extending six to ten inches above the females. To insure adequate pollen shed the male tassels are tapped or shaken several times daily for ten days. After pollination the seed or "fuzz" of the female tassel requires 28 to 35 days to mature. The seed are harvested and after drying at air temperature for two or three days they are ready for planting. However, the seed may be stored at freezing temperatures for several years if desired.

Growing Seedlings in the Greenhouse

At maturity the female tassels are cut and stripped and the amount of "fuzz" per cross is weighed. The number of viable seed per unit weight is quite variable, from 0 to 400 seed per gram, among the different crosses. For this reason a small germination test is usually run to determine how the fuzz should be spread to obtain an even distribution of seedlings in the seedling flats.

The seed are then sown in a sterilized soil, sand, peat mixture and covered lightly. Sugarcane seed germinate immediately and seedling coleptiles are usually visible within 72 hours after planting.

The seedlings require constant attention during their stay in flats (4 to 6 weeks). Frequent watering, fertilizer, insecticide and fungicide applications are made until they develop sufficiently for transplanting without appreciable loss. Seed are generally sown at L.S.U. beginning the first week of January and the potting operation is commenced the first or second week in February.

Until recently each seedling was transplanted singly to small clay pots after sufficient development in the flats, however, many seedlings are now bunch planted (in groups of 2 to 10 seedlings per pot) to somewhat larger pots. When large enough the seedlings are inoculated with the mosaic virus. Symptoms of the disease appear on the young seedlings within two weeks after inoculation and infected seedlings are discarded. Bunches are also inoculated by spraying and clipping but mosaic seedlings are not rogued in the greenhouse.

Growing Seedlings in the Field

Beginning about the middle of April, each seedling surviving the mosaic test is space planted to the field on regular six foot rows. Spacing of the seedlings in the field has been adjusted from 24 inches to 16 inches in recent years to accommodate larger numbers on the same acreage. Commercial varieties are interplanted with the seedlings for comparison.

No selection is practiced in Louisiana in plant cane seedlings due to our short growing season. In this respect our selection program differs from all others in the world. Field selection begins in the stubble seedling crop. The numbers of seedlings are greatly reduced at this time based on characteristics such as number of stalks, size of stalks, vigor or height, growth habit, brix in relation to the standards, absence of pith, diseases and other defects, etc. Selection of seedling nurseries must be confined to the first few weeks of October; after sufficient maturity yet before any danger of killing frost. The normal compliment of seedlings in the field each year represent almost 18 miles of row which must be walked and on which each seedling must be observed individually.

The selected canes are then planted to eight foot plots as soon after selection as possible. Again standard varieties (Co. 290, C.P. 34-120, C.P. 36-105, and C.P. 48-103) are interplanted with the selected canes. Sucrose analyses (5 stalk samples) are run on all plots and on the standards simultaneously. Those canes in the eight foot plots that meet minimum standards for sucrose, type, vigor and stand are then increased to twelve foot plots.

The next fall, observations and sucrose analyses are made in both the eight foot stubble and twelve foot plant cane plots. After evaluation of all available data and observations in the stubble and plant cane plots permanent C.P. or L. variety numbers are assigned to the varieties in conference with personnel of the U.S.D.A, from the Houma station and from Canal Point, Florida. Under the present system of naming varieties the letters designate where the seedling was produced, the first two digits the year the permanent number was assigned and the remaining digits the selection number. To illustrate, the variety C.P. 52-68 came from a seedling produced at Canal Point, Florida. The variety was named at the Baton Rouge Station in 1952 and was the 68th assignment of that year.

Seed cane of the assigned varieties are supplied to agronomists at L.S.U. (Mr. E. C. Simon) and Houma (Dr. L. P. Hebert). They are increased and selected further at the two stations and sent to outfield test plots and to primary increase stations. The primary stations located at Smithfield in West Baton Rouge Parish, Southdown in Terrebonne Parish, and New Hope in Iberia Parish are under the supervision of Mr. L. L. Lauden of the American Sugarcane League. Promising varieties are further increased on numerous secondary stations located throughout the belt and released to growers when the seed supply is adequate and sufficient data available to recommend the variety for commercial planting.

Table I shows the path a commercial variety, should there be one among seedlings planted this season, will follow toward release. Under the present system each released variety undergoes ten to eleven years of selection and testing before release. At this time a release statement is prepared jointly by the U.S.D.A., American Sugarcane League, and the L.S.U. Agricultural Experiment Station. The statement gives a good description of the variety and points out its strong points and weaknesses as nearly as could be determined by the data available.

SUMMARY

In this paper an attempt has been made to outline the present system of breeding and selection of varieties of sugarcane for Louisiana. This system has evolved over a period of many years. It was constantly modified as conditions warranted and will continue to change as data on new or different methods are accumulated. Attempts are presently being made to evaluate different methods simultaneously with the selection work.

Table I. The different stages of testing and selection of sugarcane varieties. The number of canes at various steps are approximate figures for L.S.U. only and single stool selections only.

Date	Stage of Selection or Testing	Approx. No. in Field
1959	Plant cane seedlings	35,000
1960	Stubble seedlings	35,000
1961	Eight foot increases	1,000
1962	Twelve foot increases	250
1963	C.P. and La. assignments	40
1964	Increase by infield agronomists	20
1965-67	Primary stations and test fields	5
1968-69	Secondary stations	3
1969-70	Released to growers	1

THE IMPORTED FIRE ANT PROGRAM AND ITS EFFECT ON THE SUGAR CANE BORER

E. A. Cancienne

The eradication of the imported fire ant, an insect pest which has been established in Louisiana for some fifteen years or more, was begun in this state in October of 1957 by the Division of Entomology of the Louisiana Department of Agriculture, together with the Plant Pest Control Division of the U.S.D.A. Agricultural Research Service. The program is financed by funds appropriated by Congress and State Legislature and from property owners in the infested areas.

Treatment of an eradication area is effected by the application of 20 pounds of 10 per cent granulated heptachlor per acre broadcast by aircraft or jeep-mounted Buffalo turbines. The toxicity of the material used is recognized by the control agencies, and precautionary measures to protect the lives and health of men and animals have been developed and are being followed in all areas where treatments are being carried out.

Residents in areas to be treated are notified in advance and requested to take certain precautionary measures before treatment is started.

As of January 1, 1959, 175,651 acres had been treated in the state of Louisiana under the cooperative State-Federal eradication program. The program has been a success, and the ant kill in the treated areas exceeded all expectations.

Obvious kills of wildlife have been reported in a few areas where treatment was conducted, but in each instance where this occurred, these losses could be attributed to some unnatural condition or unexpected turn of events.

The buildup of sugar cane borer population following treatment of sugar cane lands with heptachlor was one of the results of the program which no one anticipated. It is known that granulated heptachlor will kill the sugar cane borer, and this was shown to be true, for following the application of this material in May and June, it was reported that the treatment was doing an effective job in the control of this insect in the fields where it was applied.

In August of 1958, it was called to the attention of the regulatory officials that the population of the sugar cane borer seemed to be considerably higher in areas where heptachlor had been applied. An immediate survey was conducted in the parishes of West Baton Rouge, St. Mary and Iberia. The results of this survey showed this report to be true. Bored joints were more numerous in treated fields than in those which had not been treated. In order to get an accurate estimate of the extent of damage, a final survey was made in October of 1958, in the parishes of Iberia, St. Mary, Lafayette and West Baton Rouge, timing the survey as near as possible to the harvest date. The procedure used was to measure five feet of row and examine the joints of all stalks within the measured area for borer damage. Examinations were made in fields where heptachlor was applied and no borer treatment was carried out, fields in which heptachlor was applied followed by one or more applications of Ryania, fields in which no heptachlor was applied followed by one or more application of Ryania and fields in which no heptachlor was applied and no borer treatment was attempted. No counts were made in fields where Endrin was used, as the borer population in these fields remained very low, regardless of whether heptachlor had been applied or not. Results of this survey showed that twenty-nine fields in which heptachlor had been applied early in the season and no borer treatment had been carried out had an average of 58.84 percent joints bored. Thirty fields in which no heptachlor and no borer treatment had been applied showed an average of 41.12 per cent joints bored.

It can be assumed from this survey that the heptachlor treatment resulted in an increase in borer population causing an increase of about 20 per cent in the number of joints bored. Fields in which heptachlor was applied followed by Ryania remained heavily infested with borers, showing that Ryania was not doing an effective job in controlling the borers in these fields.

We can conclude from the results of the survey that the heptachlor destroyed great numbers of predacious insects when it was applied in the early part of the season, as well as a goodly number of sugar cane boeres. The borers from the untreated fields in adjacent areas moved back into these treated fields later in the season while the predators did not. The borers were then unmolested and built up in enormous proportions.

Where the imported fire ant program is being continued in sugar cane growing areas, sugar cane farmers who are requesting treatment of sugar cane lands are informed of the conditions experienced last season, and it is emphasized to them that an increase in borer population can be expected. If they insist on the treatment, it is recommended to them that they use Endrin for borer control, as this material has proven to be effective in controlling the borers where heptachlor was applied.

EFFECT OF TRASH AND TOPPING ON QUALITY OF HARVESTED SUGARCANE

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Since the advent of mechanical harvesting of sugarcane, trash in mill cane and improper topping have created serious problems in both harvesting and milling. Many studies have been carried out emphasizing the effects of trash upon milling (5, 8), clarification (3), sugar recovery (2), and quality (4) of harvested sugarcane. Reports of such work have pointed out that trash decreases milling capacity, introduces impurities into the juice, reduces extraction and recovery of sucrose, and increases harvesting costs. Most previous studies have involved direct comparisons of clean cane (cane with the trash removed) and trashy cane (cane with none of the adhering leaves removed). Arceneaux and Davidson (2) compared clean cane with cane containing varying amounts of green or dry trash added before milling.

In practice, the trash problem is considerably aggravated by wet weather. Immediately following rainy weather during the harvesting season, sucrose, purity, and recovery of sugar decrease considerably. Various explanations of these decreases have been advanced. It has been suggested that the plants take up considerably more water from the soil following a rain; also, that during wet weather the plants start growing at an increased rate, and that this vegetative condition affects the quality (Brix and sucrose) of the juice. Some have attributed the losses to a leaching effect from the wet conditions. A more probable explanation would be a dilution effect from the water retained on the stalks and in the trash. The studies reported here dealt directly with the effects of wet trash on the quality of juice, extraction, and value of harvested sugarcane.

It has been recognized for a long time and research work (1, 7) proved that the level of topping has considerable effect upon the quality of juice from harvested sugarcane. Mechanical harvesting has led to the concept of "average topping" rather than the older practice of topping each stalk at the uppermost mature internode. Research work has pointed out that immature tops introduce into the crusher juice not only low-sucrose juice but also impurities which greatly affect the recovery of sugar. In addition, the upper immature joints hold a considerable amount of green trash that cannot be removed by burning. Arceneaux and Davidson (2) have shown how green trash can influence juice quality. The topping studies presented in this report were carried out to determine the extent to which lower topping with a mechanical harvester would reduce the total trash content and in turn increase the quality of the harvested sugarcane.

EXPERIMENTAL DATA

Trash experiments:

The trash experiments were carried out mainly to compare the effects of wet and dry trash upon juice quality. However, to further evaluate these effects, we also compared dry clean cane, wet clean cane, and dry trashy cane. The cane used in the tests was field-run cane which had been mechanically harvested. A truckload of such cane was sorted into samples of 20 stalks each, and 5 such samples were used for each treatment. In the preliminary test, variety N.Co. 310 was given the following treatments: (1) dry, with all the trash stripped from the stalks; (2) dry, with no trash removed; (3) stripped, but placed in the rain for 15 hours; (4) trashy, and placed in the rain; and (5) trashy, but submerged in a tank of water for 15 hours. The results of the juice analysis, gain in weight, and percent extraction are shown in table 1. They indicated such a marked reduction in sucrose and purity that further tests were carried out to confirm them and to determine whether the effects could be directly attributed to dilution from the wet trash or whether rain or soaking actually leaches sugar from the stalks.

In these tests one other treatment, soaking stripped cane for 15 hours, was added. A lawn sprinkler was used to simulate rain in these latter tests. The average results of 5 of these tests (3 with variety C.P. 44-101 and 2 with variety N.Co. 310) are shown in table 2. These data confirm the results of the original test and clearly indicate the decrease in sucrose and purity caused by the wet trash. All samples were weighed dry and then reweighed wet prior to milling. The increases in weight caused by the water are indicated in table 2. Table 2 also shows the calculated sucrose; this is the percent sucrose that would be expected in the juice if the juice were diluted with water in the amount indicated by the percent gain in weight and percent extraction. These figures agree quite closely with the observed percent sucrose.

Two additional tests were carried out to determine whether the large drop in sucrose due to soaking the stalks with the trash on them was the result of additional leaching of the sugar, or dilution of the juice. To determine this, 5 additional samples with the trash left on the stalks were soaked in water for 15 hours. Before milling, the trash was removed. The results of these two tests are shown in table 3. The data clearly show that the quality of soaked cane with the trash removed before milling is comparable with that of soaked, stripped cane, or, as shown in table 2, sprinkled stripped cane.

Since the calculated percent sucrose shown in tables 2 and 3 so nearly corresponds with the observed percent sucrose, the drop in sucrose could apparently be directly attributed to dilution. However, dilution should reduce the Brix similarly and juice purities should not be affected. The data show that purities did decrease and indicate that total solids were not reduced proportionally to sucrose. To test whether the purity drop was a characteristic of sugarcane juice or due to an increase in total solids extracted by the dilution water, a dilution experiment was conducted with raw juice. In this test, juice was diluted by volume in various amounts. These diluted juices were then analyzed. Figure 1* shows a comparison between the observed Brix and sucrose of the diluted juices and the theoretical changes in Brix and sucrose. It can be concluded from this figure that dilution of raw juice with water should decrease Brix and sucrose proportionally and not affect purity.

Another striking example of the effect of wet trash upon juice quality was shown in one field test with variety N.Co. 310. On December 8 a group of five 20-stalk samples was selected from one heaprow in the field for another experiment. During the night it started to rain and continued to rain for 12 hours (0.50 inch). Since the cane had not been hauled to the mill, 10 additional samples were taken from this heaprow and divided into two groups, one with the wet trash stripped from the stalks and the other with the trash remaining. The juice analysis and extraction for this test are shown in table 4. These data show that the milling of wet trash with field-run cane also effects a marked reduction in sucrose.

Topping experiments:

In a trash experiment carried out in 1957, it was observed that a reduction in the total amount of trash could be effected by lower topping of machine-harvested sugarcane. In this test 10 samples of N.Co. 310 from a single heaprow were analyzed and compared with 10 samples from the same heaprow in which 8 inches of cane was cut from the top of each stalk. Analysis of the juice from these two lots of cane indicated an increase in percent sucrose from 13.30 to 14.31, and an increase in purity from 80.38 to 82.86, as a result of 8-inch lower topping. Trash analysis from this experiment showed that removal of the upper 8 inches of each stalk reduced the total trash from 9.5 to 7.6 per cent. This decrease represented a 20 per cent reduction in total trash, and a 43.8 per cent reduction in green trash. Analysis of the removed top portion showed it to be of inferior quality, with a Brix of 12.59, sucrose of 7.54, and a purity of 59.89. The increased calculated value of the topped cane was equal to that of the discarded tops.

Since this test had shown that lower topping would improve the quality of harvested sugarcane and at the same time effect an important reduction in trash content, further tests were carried out in 1958 to determine to what extent lower topping would be of economic value. During 1958 nine separate tests (5 with C.P. 44-101, 3 with C.P. 36-105, and 1 with N.Co. 310) were conducted to measure the effect of various degrees of topping on juice quality and percent trash. In these tests loads of cane were obtained from a heaprow of mechanically harvested cane. The cane was made up into 20-stalk samples and into lots of 5 samples each. The treatments used were 6-inch and 9-inch additional topping.

The results with respect to trash were not as striking as those in 1957. Removal of the upper 6 inches of the stalk reduced the total trash by only 1 percent and the total amount of green trash by only 14 percent. Further work is indicated with respect to the value of lower topping as a means of reducing trash.

The results of these tests indicate that lower topping may effectively increase the quality of harvested sugarcane. Table 5 shows the average weight loss, juice analysis, and value of the cane from 9 of these topping tests. These data indicate that 6 or 9 inches of additional topping improves the quality of the cane to such an extent that its increase in value is equal to that of the loss in weight.

DISCUSSION

The effect of trash upon juice quality was clearly demonstrated in the average of 5 tests (table 2). As other workers (2, 3) have shown, dry trash alone causes a reduction in sucrose and purity. As Arceneaux and Davidson (2) pointed out, this can be attributed to a loss of sucrose in the bagasse and the addition of impurities to the juice. The experiments reported in this paper show, in addition, a decrease in sucrose and purity as a result of milling wet sugarcane, and a considerable decrease from milling wet trash cane. Stripped wet cane increased in weight from 1.9 to 2.5 percent while wet trashy cane increased in weight from 5.4 to 11.0 percent. The losses in sucrose can be explained on the basis of direct dilution from the added water and the differences in extraction. The data indicated a slight increase in extraction from milling with wet trash. Theoretically, dilution with pure water should not affect juice purity; a dilution test with raw juice demonstrated that sugarcane juice reacts according to theory. Therefore the observed decrease in purity might be attributed to the extraction of a greater amount of nonsucrose solids with water from the trash. It was shown that the sucrose and purity losses could not be attributed to leaching or to an increased absorption of water due to the presence of trash. Values of sugarcane calculated on the basis of the sucrose and purities observed indicate a loss of more than a dollar per ton as a result of milling wet trashy cane. Similar losses were reported for a field test following a rain.

Nine separate topping tests indicated that average field-run mechanically harvested sugarcane could be effectively topped 6 to 9 inches lower than normal. Data in table 5 indicate that lower topping increased the sucrose and purity of the juice. This has the effect of increasing the value of cane nearly one dollar per ton, which is slightly greater than the value of weight loss. Analyses of top portions removed by lower topping showed the tops to be of sub-standard quality.

Lower topping also reduced the total trash by 1 percent and reduced the total amount of green trash by about 14 percent. The increases in juice quality and reduction in trash as the result of lower topping may not appear to be justified economically. However, any practice which improves the quality of cane delivered to the mill and reduces the total quantity of cane to be ground, may be of considerable economic importance following a freeze.

SUMMARY

The presence of wet trash in sugarcane harvested for milling directly affects the quality of juice by diluting the sucrose. The purity of the juice is reduced by the extraction of nonsucrose solids with the water retained in the trash. These losses are of economic importance to both growers and processors.

Lower "average topping" would effectively increase the quality of the cane delivered to mills without an economical loss to the growers, and under certain conditions would effect a practical gain to both growers and processors.

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*Figure not included for publication.

Table 1. Effect of wet and dry trash on juice analyses, weight, and extraction of N.Co. 310 sugarcane harvested for milling November 3, 1958, Houma, La.

Treatment	Brix	Sucrose	Purity	Weight gain	Extraction
	o	%		%	%
Dry - Stripped	16.41	13.46	82.02	-	57.9
Dry - Trash	15.61	12.41	79.50	-	56.5
Wet - Stripped	15.98	13.12	82.10	1.9	60.1
Wet - Trash	15.00	12.12	80.80	4.6	58.4
Soaked - Trash	12.79	9.80	76.62	11.1	58.1

Table 2. Effect of dry and wet trash on juice analyses, extraction, and value of sugarcane harvested for milling, Houma, La., 1958. (Average of 3 tests of C.P. 44-101 and 2 tests of N.Co. 310)

Treatment	Brix	Sucrose	Purity	Calculated sucrose	Weight gain	Extraction	Value/T*
	o	%		%	%	%	$
Dry - Stripped	17.37	14.34	82.56	-	-	56.9	8.42
Dry - Trash	16.45	13.41	81.52	-	-	56.4	7.85
Sprinkled - Stripped	16.71	13.77	82.40	13.92	+1.9	57.5	8.07
Sprinkled - Trash	15.06	12.13	80.54	12.39	+5.4	57.9	7.02
Soaked - Stripped	16.83	13.95	82.89	13.77	+2.5	57.8	8.21
Soaked - Trash	14.16	11.25	79.45	11.78	+9.6	58.6	6.46

* Calculated - Standard tones X $1.06 X 6.338

Table 3. Effect of dry and wet trash on juice analyses, extraction, and value of C.P. 44-101 sugarcane harvested for milling, Houma, La., 1958. (Average of 2 tests)

Treatment	Brix	Sucrose	Purity	Calculated sucrose	Weight gain	Extraction	Value/T*
	o	%		%	%	%	$
Dry - Stripped	17.75	14.44	81.35	-	-	56.8	8.40
Soaked - Stripped	16.82	13.67	81.27	13.89	+ 2.3	57.7	7.95
Soaked - Trash	14.87	11.66	78.41	12.70	+10.4	58.5	6.64
Soaked - Trash, but stripped before milling	16.98	13.83	81.45	13.67	+ 2.2	58.7	7.52

* Calculated - Standard tons X $1.06 X 6.338

Table 4. Effect of wet trash on juice analyses, extraction, and value of N.Co. 310 sugarcane harvested for milling, Houma, La., December 9, 1958.

Treatment	Brix	Sucrose	Purity	Extraction	Value/T*
	o	%		%	$
Dry - Trash	18.18	15.04	82.72	53.3	8.79
Wet - Trash	16.62	13.59	81.76	57.0	7.92
Wet - Stripped	17.99	15.18	84.38	51.4	8.97

* Calculated tons X $1.06 x 6.338

Table 5. Effect of topping upon the quality of juice and the value of harvested sugarcane, Houma, La., 1958. (Average of 9 tests: 5 with C.P. 44-101, 3 with C.P. 36-105, and 1 with N.Co. 310).

Treatment	Weight loss	Brix	Sucrose	Purity	Conversion factor to standard tons	Value per ton*	Gain in value	Value of weight loss
	%	o	%			$	$	$
Whole stalk	-	16.54	13.41	81.08	1.165	7.83		-
Upper 6 inches of stalk removed	4.66	16.47	13.82	83.91	1.217	8.18	0.35	0.36
Upper 9 inches of stalk removed	7.83	17.54	14.85	84.66	1.313	8.82	.99	.61
6-inch top section	-	12.43	7.22	58.08	-	-	-	-
9-inch top section	-	12.13	7.73	63.73	-	-	-	-

* Value calculated - Standard tons X $1.06 X 6.338.

CONTROL OF THE SUGARCANE BORER WITH INSECTICIDES

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The sugarcane borer, *Distraea saccharalis* (F.), has been the most serious and destructive insect attacking sugarcane in Louisiana for many years. Present estimates indicate that cane growers of the state have suffered an average annual loss to the sugarcane borer amounting to about 13 percent of their sugar yields since 1937.

Sodium Fluosilicate, cryolite and ryania dust have been recommended and used successively for cane borer control in Louisiana since the early 1920's. A dust containing 40 percent ryania was used almost exclusively for several years prior to 1958 by growers who attempted to control the borer.

A summary of results from over 20 fields tests (1) indicates that four weekly applications of ryania dust for control of second generation borers gave 48 ± 15 per cent (95 percent confidence interval) control based upon the percentage of joints bored at harvest. This degree of control gave an average yield increase of 1018 - 686 pounds of sugar per acre. In other tests eight weekly applications of ryania dust for control of both second and third generation borers showed 68-11 per cent control with an average yield increase of 1433 - 606 pounds of sugar per acre.

Endrin was first tried in 1951 for sugarcane borer control in

Louisiana (2). Forty-nine per cent of sugarcane borers was obtained in a field test using an experimental formulation of endrin dust as compared to 97 per cent control from comparable ryania treatments.

Four and eight applications of 2 per cent endrin dust showed 50 and 56 per cent control, respectively, of borers at harvest in 1955 (3). Respective yield increases of 1004 and 1674 pounds of sugar per acre were reported. In the same test four and eight applications of 40 per cent ryania dust gave 23 and 45 per cent control with estimated yield increases of 403 and 1181 pounds of sugar per acre, respectively. In spite of these results it was concluded at this time that "there is no place for organics in the cane area as a whole, because of their toxicity to the natural enemies of the borer." In the presence of accumulated data which indicated that some borer control accompanied by surprisingly large increase in crop yields could be obtained by using from four to eight applications of 40 per cent ryania dust, most growers did not take full advantage of recommended chemical control practices. Those who did use ryania or cryolite usually made four weekly insecticide applications for control of second generation borers, and often supplemented these insecticide applications with releases of Trichogramma egg parasites.

Endrin was first recommended for control of the sugarcane borer in Louisiana in 1958 (4). Field tests conducted since 1955 with endrin and other insecticides are considered in the remainder of this paper.

METHODS OF PROCEDURE

Insecticides were applied by airplane to large-plot tests since aerial application is the most common and often the only practical or possible means of applying chemicals to large acreages of sugarcane. In a small-plot test insecticides were applied from a quart-size glass fruit jar equipped with a metal top in which several holes were punched. The jar was inverted and fastened at an angle to one end of a long pole so that granular insecticides could be sprinkled over the row from above the tops of tall cane while the worker walked in the middle between rows.

Attempts were always made to apply all of the insecticide formulations used at the uniform rate of 12 pounds per acre per application. The actual rate of application on a few large plots differed appreciably from that intended; however, these departures from the intended rate were mostly overdoses and apparently had little, if any, effect on the degree of borer control obtained.

Airplane-treated plots ranged in size from 1.6 to over 10 acres, their size and shape commonly being determined by the size, shape and number of cuts comprising the field to be treated. In the small-plot test plots were three rows wide and 24 feet long (1/100 acre).

The direct effect of treatments upon borer populations were estimated by determining the per cent of joints or internodes having external signs of borer tunneling at the time of harvest.

Yields from large plots were estimated by weighing machine-cut cane from 300 row-feet, or by hand-cutting and weighing several 1/1000-acre samples from each plot. Weights were always taken from areas approximately equidistant from the sides of the plots and not closer than 50 feet from the nearest headland. Weights were obtained in small plots by hand cutting and weighing all of the cane in each plot.

Juice analyses for sucrose and brix content were made on the juice from 10 to 30 stalks selected at random from each plot.

A complete block experimental design was employed in all of these field experiments with treatments assigned at random to each block.

RESULTS

1956 Test

Eight applications of each insecticide listed in Table I were made by airplane at weekly intervals to large plots of sugarcane located near Bunkie, Louisiana.

Bored joint counts made at harvest show that endrin dust or granules gave almost complete control. Toxaphene and ryania treatments gave 78 and 69 per cent control, respectively. The difference between each treatment and the check was greater than that required for significance at the 5 per cent level.

Treatment with endrin dust or granules resulted in yield increase of more than six tons of cane and approximately one ton of sugar per acre. The difference in yields of sugar per acre between plots treated with endrin and plots which received no insecticide treatment were greater

Table I. Summary of Results from Large-Plot Insecticide Experiment Conducted on the Bubenzer Farm Near Bunkie, Louisiana, During 1956[a]

Treatments[b]	Per Cent Joints Bored	Yields Increase Per Acre	
		Tons of Cane	Pounds of Sugar
Ryania 40% dust	20	2.4	1085
Toxaphene 20% dust	14	4.4	998
Endrin 2% dust	2	6.6	1847
Endrin 2% granules	1	6.7	2050
Check No insecticide	64	21.7[c]	2429[c]
Tukey's D[d]	22	7.2	1179

[a] Sugarcane varieties C.P. 36-13 and C.P. 36-105, plant cane. Figures are averages of 4 replications.

[b] Eight applications of each insecticide were made at weekly intervals.

[c] Actual yields from untreated plots.

[d] Differences required for significance at the 5 per cent level.

than the amount required for significance at the 5 per cent level. Yield increases following treatment with toxaphene or ryania were about half as large as those found in endrin-treated plots.

1957 Test

Endrin and toxaphene were applied by airplane to large plots of sugarcane grown by the Island Planting Company near Bunkie, Louisiana. Table II shows the results from this test in which eight weekly applications were compared with four biweekly applications of each insecticide for control of both second and third generation borer.

Endrin granules gave the best control obtained in this test. Results with toxaphene were generally intermediate between those for endrin granules on the one hand and endrin dust on the other. Insecticide granules always gave better control than comparable dust formulations. Eight weekly applications were generally superior to four biweekly applications, but the difference between four and eight applications was relatively small when granular formulations were applied. An analysis of variance of the bored joint data showed that the average differences between weekly and biweekly insecticide applications, and between dust and granular formulations were significant at the 1 per cent level. The interaction between insecticides and formulations (carriers) was also significant at the 1 per cent level.

The largest yields of cane and sugar per acre were found in plots receiving four or eight applications of endrin granules. These treatments increased yields by approximately eight tons of cane and three-fourths of

Table II. Summary of Results from Large-Plot Insecticide Experiment Conducted on the Island Planting Company Farm Near Bunkie, Louisiana, During 1957[a]

Treatment[b]	Per Cent Joints Bored	Yield Increase or Decrease Per Acre	
		Tons of Cane	Pounds of Sugar
Endrin (4) 2% dust	43	-1.8	- 451
Endrin (8) 2% dust	34	2.4	- 40
Endrin (4) 2% granules	5	8.4	1446
Endrin (8) 2% granules	2	8.0	1450
Toxaphene (4) 20% dust	34	1.3	504
Toxaphene (8) 20% dust	20	3.8	927
Toxaphene (4) 20% granules	17	3.4	1190
Toxaphene (8) 20% granules	13	0.6	392
Check No insecticide	52	27.5[c]	4270[c]
Tukey's D[d]	22	4.9	1860

[a] Sugarcane variety C.P. 36-13, plant and second ratoon crops. Figures are averages of 4 replications.

[b] Parentheses contain the number of insecticide applications made (8 weekly or 4 biweekly).

[c] Actual yields from untreated plots.

[d] Differences required for significance at the 5 per cent level.

a ton of sugar per acre. Applications of endrin dust gave no important yield increases. Plots treated with toxaphene yielded more cane and sugar per acre than check plots, but less cane and sugar per acre than plots treated with endrin granules. An analysis of variance showed that the average difference in yield of sugar per acre between dust- and granule-treated plots was significant at the 1 per cent level. The interaction between insecticides and formulations (Carriers) was also significant at the 1 per cent level.

1958 Demonstration Plots

Table III is a summary of results from large demonstration plots located on seven different plantations in six different parishes of southern Louisiana. Four biweekly applications of endrin and ryania for control of second and third generations borers were compared with no treatment. An experimental granular formulation containing 40 per cent ryania was used on three plantations, and the commonly used 40 per cent ryania dust was used on the remaining four.

Two per cent endrin granules gave much better control than was afforded by the ryania treatments. The effects of ryania dust and granules were averaged together since the average difference between them in control obtained was only 3 per cent. The difference in per cent of joints bored between endrin-treated and ryania-treated or untreated plots was larger than that required for significance at the 5 per cent level.

Data from Table III show that yield increases on endrin-treated

Table III. Summary of Results from Large Demonstration Plots Located in Several Parishes of Southern Louisiana During 1958[a]

Treatments[b]	Per Cent Joints Bored	Yield Increase Per Acre Tons of Cane	Yield Increase Per Acre Pounds of Sugar
Endrin			
2% granules	7	7.4	1194
Ryania[c]			
Dust and granules	32	3.3	665
Check			
No insecticide	37	25.4[d]	4757[d]
Tukey's D[e]	11	3.9	822

[a] Figures are averages of 7 replications located on 7 different plantations in 6 different parishes of southern Louisiana. The sugarcane variety C.P. 44-101, C.P. 48-103 or C.P. 36-13 was grown in all demonstration plots on each plantation.

[b] Four applications of each insecticide were made at biweekly intervals.

[c] Forty per cent ryania granules were used in 3 replications and 40 per cent ryania dust in the remaining 4.

[d] Actual yields from untreated plots.

[e] Differences required for significance at the 5 per cent level.

plots were about twice as large as those measured in ryania-treated plots. The difference between yields of cane and sugar per acre from endrin-treated and untreated plots were greater than the amounts required for significance at the 5 per cent level. The average difference in yield of cane per acre between endrin- and ryania-treated plots was greater than that required for significance at the 5 per cent level.

1958 DDT Test

Four biweekly applications of 5 per cent DDT granules were compared with comparable treatments of 2 per cent endrin granules and 40 per cent ryania dust in large plots on Waterford Plantation in St. Charles Parish.

Data from Table IV show that endrin gave far better control of borers than either of the other insecticides used. The difference in per cent of joints bored between ryania-treated and untreated plots was the only one among all possible comparisons which was not as large as the difference required for significance at the 5 per cent level. Treatment with DDT resulted in a significant increase in borer damage.

Average yield increases of slightly more than 11 tons of cane and over one-half ton of sugar per acre resulted from four biweekly applications of endrin granules. Relatively small increases in yield followed treatments with ryania. Estimated yields were actually smaller in DDT-treated plots than in check plots which received no insecticide treatment.

Table IV. Summary of Results from Large-Plot Insecticide Experiment Conducted on Waterford Plantation in St. Charles Parish, Louisiana, During 1958[a]

Treatments[b]	Per Cent Joints Bored	Yield Increase or Decrease Per Acre: Tons of Cane	Yield Increase or Decrease Per Acre: Pounds of Sugar
DDT 5% granules	50	- 2.0	- 482
Endrin 2% granules	7	11.1	1191
Ryania[c] Dust and granules	35	3.2	294
Check No insecticide	32	29.9[d]	4689[d]
Tukey's D[e]	4	5.3	730

[a] Sugarcane variety C.P. 44-101, first ratoon. Figures are averages of 4 replications.

[b] Four applications of each insecticide were made at biweekly intervals.

[c] First application with 40 per cent ryania dust; last 3 applications with 40 per cent ryania granules.

[d] Actual yields from untreated plots.

[e] Difference required for significance at the 5 per cent level.

1958 Small-Plot Test.

Granular formulations of several insecticides were compared in a small-plot test conducted on Belleview Plantation near Franklin, La.

Four biweekly applications of endrin, thiodan, heptachlor and sevin, respectively, caused appreciable reductions in borer damage (Table V). Treatment with trithion or ryania suppressed borer damage to some extent. DDT was apparently responsible for an increase in borer damage. The injury suffered in plots treated with endrin, thiodan, heptachlor and sevin differed significantly at the 5 per cent level from that found in untreated plots. Endrin and thiodan gave significantly better control than any other insecticide treatments.

Significant increases in yield of cane and/or sugar per acre followed treatment with endrin and thiodan, respectively. Favorable responses in yield were measured following treatment with all of the other insecticides used except DDT, which was apparently responsible for some decrease in yield.

DISCUSSION

The weight of accumulated data points conclusively to the fact that endrin is a far better chemical for controlling the sugarcane borer than any other that has been so thoroughly tested at this time. For this reason it is the only insecticide currently recommended in Louisiana for borer control on sugarcane.

Four biweekly applications of 2 per cent endrin granules broadcast

Table V. Summary of Results from Small-Plot Insecticide Experiment Conducted on Belleview Plantation Near Franklin, Louisiana, During 1958[a]

Treatments[b]	Per Cent Joints Bored	Yield Increase or Decrease Per Acre: Tons of Cane	Yield Increase or Decrease Per Acre: Pounds of Sugar
Endrin 2% granules	5	6.1	1353
Thiodan 5% granules	5	5.0	1026
Sevin 5% granules	26	3.9	632
Heptachlor 5% granules	16	3.4	463
Trithion 5% granules	32	3.8	784
DDT 5% granules	47	-1.0	-564
Ryania 40% granules	32	2.8	421
Ryania 30% granules	32	2.8	417
Check No insecticide	40	24.5[a]	5649[c]
Tukey's D[d]	10	4.4	1044

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[a] Sugarcane variety C.P. 44-101, first ratoon crop. Figures are averages of 6 replications.

[b] Four applications of each insecticide were made at biweekly intervals.

[c] Actual yields from untreated plots.

[d] Differences required for significance at the 5 per cent level.

at the rate of 12 pounds per acre have given very good control of second and third generation cane borer. During 1958 the average total cost of four airplane applications of endrin granules was slightly less than $10.00 per acre. This means to the grower that he must obtain an increase of slightly more than one ton of standard cane per acre to pay for the cost of treatment. The above data show average yield increases ranging from 6 to 11 tons of cane per acre following treatment with endrin.

Though endrin is now widely accepted by Louisiana sugarcane growers as the best "medicine" for the sugarcane borer, there was early opposition to its use by some who feared that the use of an organic insecticide for borer control in Louisiana's Sugar Belt might eliminate some important natural enemies of the borer and thereby increase the overall problem of borer control. Data presented above for DDT and other data (5) show that such upsets can and have occurred following insecticide use in sugarcane fields. Recent studies to determine what effect field applications of endrin will have on insect predators commonly found in Louisiana cane fields will soon be published by Hensley _et al_.

SUMMARY

A brief history of the use of insecticides in Louisiana to control the sugarcane borer, _Distraea saccharalis_ (F.), is followed by recent results from field tests conducted during 1956, 1957, and 1958.

Very good and profitable borer control has always been obtained from four biweekly applications of 2 per cent endrin on 30-60 mesh

RVM-AA attapulgite granules broadcast over cane fields at the approximate rate of 12 pounds per acre per application. Results with dust formulations of endrin have not always been good. There is no appreciable difference between the control obtained or yield increases resulting from eight weekly or four biweekly applications of endrin granules.

While some insect control and yield response usually follows treatment with 40 per cent ryania dust, this insecticide is much inferior to endrin as chemical for controlling the sugarcane borer. An experimental granular formulation containing 40 per cent ryania gave no better control than the commercial preparation of 40 per cent ryania dust.

A granular thiodan formulation was the only insecticide among several tested which gave control comparable to that resulting from endrin treatment.

Treatment with DDT increased losses to the sugarcane borer.

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ENDRIN FOR SUGARCANE BORER CONTROL - A LOOK INTO THE FUTURE

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A revolution in control of insects occurred a little over a decade ago when the chlorinated hydrocarbon insecticides were introduced. Use of such materials as DDT, BHC, toxaphene, chlordane, aldrin, dieldrin, heptachlor and endrin, followed by the organophosphorus compounds, parathion, malathion, methyl parathion, demeton, diazinon, thimet, Korlan and Co-Ral and more recently by the carbamate Sevin, has allowed for the effective and economical control of many important insect pests which formerly could not be controlled at all. Other pests have been controlled more effectively and economically with these new insecticides.

Until 1954 when chlordane was first recommended for control of soil pests in heavy soils, none of these newer insecticides had found a place in sugarcane insect control. Nearly all of the materials listed above have been tested during their development for control of the sugarcane borer. None had proved to be effective enough to justify their being used until the development of granular formulations of endrin. Beginning in 1958 with the recommendation and use of endrin for control of the sugarcane borer, a new era in the control of this pest has begun. I have been asked to discuss what we may expect from the widespread use of this potent new insecticide on sugarcane.

It should be emphasized at the beginning of such a discussion that the course of future events can never be predicted with certainty. Not being clairvoyant, what I shall have to say to you on this subject must be considered as being speculative. However, by study and evaluation of past events the course of future events may often be projected with a reasonable amount of accuracy.

Widespread use of these newer organic insecticides on other crops has not proved to be an unmixed blessing. Many of these materials are known to be highly toxic to the human being. There have been deaths caused by exposure to some of them. Parathion especially has caused several deaths. In general, the chlorinated hydrocarbons are not especially hazardous from the standpoint of toxicity to the human being. However, endrin is one of the most toxic of this group of insecticides and must be handled carefully. If reasonable care is used in handling it, we may expect no trouble. The granular formulation is relatively non-hazardous. About 400,000 pounds, equivalent to about 20,000,000 pounds of 2 per cent granules, have been used on cotton in Louisiana since 1953, much of it as the comparatively dangerous emulsifiable concentrate, with no trouble.

Many of these newer insecticides are hazardous to wild life. The chlorinated hydrocarbon insecticides generally have proved to be especially toxic to fish. Endrin is certainly one of the most potent of these. It will kill many species of fish at concentrations of 0.00003 ppm. It is also known to be quite toxic to mice and is recommended in the apple orchards in many states for the control of meadow mice at the rate of 2 pounds or more per acre. Sugar cane will receive 1 pound of the technical material per acre per year. Certainly four applications at 1/4 pound per acre per application spread over a 2 month period are not as potentially hazardous to wild life as 2 pounds applied in one application. Nevertheless, we may reasonably expect some kill of wild life in cane fields and certainly large fish kills may be expected unless applications are made very carefully.

One point upon which information is lacking is whether heavy rains will move enough of the material into streams to cause trouble. Past experience must be depended upon at this time for an answer. Experience gained from several years of heavy use on cotton indicates that there will be no trouble except from direct application or drift to bodies of water.

Residues of insecticides on food crops are no more of a problem with the newer insecticides than with many of the older materials. For example, cryolite and DDT have about the same tolerance on most fruits and vegetables. Ryania does not require any restrictions of residues on food crops since it is considered to be relatively non-toxic to man. In spite of its relative toxicity, endrin is generally recommended for control of vegetable pests such as cabbage ceterpillars and aphids, flea beetles, cutworms and Colorado potato beetles.

One of the most serious problems which has arisen from the use of these new insecticides has been biological upsets which have resulted in increased injury from various pests; or, pests which were injurious only occasionally have caused injury more frequently. Destruction of predators and parasites has often allowed minor pests to assume major importance. For example, spider mites have apparently become of greater importance on a worldwide scale since these insecticides were introduced. The red banded leafroller has become a major pest of apple in some areas; the bollworm has become an annual pest of cotton rather than an occasional pest; and finally, we are all aware of the effect of the fire ant program on sugarcane borer infestations last year.

At the same time that previously unimportant pests have become important following use of these materials there are a number of examples where their use has resulted in major pests becoming of no significance. For example, the cotton leafworm which was responsible for the use of more insecticides than any other cotton pest prior to 1945 is no longer of any significance in the United States.

Predaceous and parasitic insects are of vital importance in the control of insect pests. On crops where they are effective full use should be made of these natural control agents. However, many of our pests are not effectively controlled by predators and parasites. The sugarcane borer in Louisiana is one of this group. During the period 1935-58 losses to the sugarcane borer have ranged from 4 to 20 and have averaged 13 per cent. This is rather expensive share-cropping with an insect pest.

Last year in areas involved in the fire ant eradication program an estimated loss of 48 per cent of the crop occurred in fields which were not treated at all or where ryania was used, where Trichogramma were liberated, or where ryania and Trichogramma were used together. In the same area but outside of the fire ant treatment zone this loss amounted to an estimated 33 per cent of the crop. In other words, the loss in areas expecting a 20 ton crop per acre amounted to an estimated 9 1/2 tons where the fire ant treatment caused an upset in natural control, but 6 1/2 tons were lost in the same locality where no fire ant treatment was made. It is obvious that parasites and predators have not done an effective job of controlling the sugarcane borer in Louisiana. Over 6 tons of cane per acre is a high price to pay toward maintaining "natural balance."

The usual idea of nature being in balance is a popular myth. The fallacy of this popular misconception is well illustrated by examples provided in the geological record. Paleontological studies have provided a history of a continuous succession of plants and animals which have come into existence, flourished for a while, and then become extinct. It is true that forces are at work which constantly strive to bring about a balance in nature. However, it is man's ability to keep nature so far out of balance that makes it possible for us to have all the material possessions which have become so important to society today. It is man's ability to keep nature out of balance which has permitted the population of this country to increase from about one million people eking out an existence in what might be termed a balanced environment to over 175 million plagued with excess production of food and fiber. This tremendous population growth has taken place in about 3 centuries. It is obvious that nature must be thrown even more out of "balance" if this rapidly increasing population is to be adequately fed and clothed.

The idea has been expressed that once endrin is used in a field it will have such a drastic effect upon predators and parasites of the sugarcane borer that control measures will have to be applied every year afterward. Certainly endrin will destroy many more of these beneficial insects than ryania. Our data so far show that it has little effect on Trichogramma but it has reduced the populations of a complex of suspected predators of the sugarcane borer about 50 per cent. It could be that use of endrin will allow some hitherto unknown potential pest of sugarcane to develop into an important pest. However, the same possibility existed when cryolite and ryania were first used, or when any insecticide is first used commercially. All insecticides must be capable of upsetting the so-called balance of nature or they would not control any insect.

Experience with cotton does not lend basis to the idea that once endrin is used a powerful insecticide must be used every year thereafter in steadily increasing amounts. After more than 10 years of use of chlorinated hydrocarbons in Louisiana many growers in North Louisiana were able to make a crop in 1958 without finding it necessary to make more than two or three applications of insecticide. Had they been willing to contribute 10 to 15 per cent of their crop to insects, it would not have been necessary to use any insecticide.

The expression "we don't want what has happened in cotton to happen to cane" has been heard frequently during the last few years. It would be most instructive for those who have expressed this thought to discuss the matter with cotton growers. It is safe to say that not a half-dozen cotton growers in Louisiana would turn back the clock in insect control to calcium arsenate,, nicotine sulphate and sulphur. The same thing will prove to be true in cane.

Use of insecticide on cotton during the last decade has increased tremendously, not because of any upset of natural balance, but because of the spectacular results achieved. In 1947 it was difficult to find enough growers to cooperate in experimental work. They did not believe insects could be controlled economically. For the past several years our greatest difficulty has been in trying to convince them that they are using about twice as much insecticide as is actually needed. Instead of considering insecticides as a tool to use in protecting the crop when populations of insects become numerous enough to cause damage, many cotton growers have come to consider an insecticide in much the same manner as they think of a fertilizer. Obviously this is a serious mistake. Insecticides should be applied only when pests are present on a crop in numbers enough to cause damage.

Increases in yields resulting from the use of these insecticides have been so spectacular it is easy to understand why growers have used far more of them than has been necessary to control pests efficiently. For example, a study just released by the U. S. Department of Agriculture shows that yields from treated plots in tests in Central Texas have been 53 per cent greater than from untreated plots since 1945 when the first chlorinated hydrocarbon was introduced. Prior to 1945 when the inorganic insecticides such as the arsenicals and sulphur were used, increases in treated plots compared to untreated plots amounted to 34 per cent. The tremendous increase in use of insecticides for cotton insect control has come about because of their effectiveness. Growers are convinced that these new materials return a profit when used. This was not the case with the inorganic insecticides.

Development of resistance to the newer insecticides has been one of the most troublesome aspects of their use. The number of insects which have become resistant to one or more insecticides increases steadily. It is entirely possible that the sugarcane borer may become resistant to endrin after several years of exposure. This would not be surprising at all. What would be greatly surprising would be the occurrence of a course of events which has been rather freely predicted by a number of individuals. These predictions, arrived at by some extremely curious mental gymnastics, would have the sugarcane borer becoming resistant to endrin while at the same time all predators and parasites would be eradicated. This is double standard thinking developed to a high degree. First of all, there is just as much chance of eradicating the sugarcane borer as there is of eradicating any of its parasites and predators. It is safe to assume that neither will be eradicated. Secondly, the same selective forces exerted by endrin on the sugarcane borer which might result in its becoming resistant to the material are operating in the same manner on parasites and predators and may just as reasonably be expected to develop resistance in these species.

Even though resistance in these insecticides has developed in many pests, effective and economical control measures are still available for them all. For example, we have for this season the most economical program that has ever been developed for control of the boll weevil in spite of the fact that it has become highly resistant in many areas to the chlorinated hydrocarbon insecticides.

To refrain from using endrin on the grounds that the sugarcane borer may become resistant to it, is analogous to growers not using 44/101 when it was first recommended because of the possibility that such a new variety might at some time in the future become susceptible to mosaic, as indeed it has. Further analogies could be drawn. For example, use of penicillin has had some undesirable side effects. Actually a number of deaths have been reported following its use. How many of you would like to withdraw use of penicillin from the medical profession?

It is true that the newer insecticides have created some problems. It is equally true that for each problem they have created they have solved dozens of far more importance to humanity. By the use of these materials it has been possible to control pests for the first time in our history effectively and economically. They have also made it possible to demonstrate for the first time that insects not known to be of any importance are actually important pests. Their use has almost completely eliminated malaria from many areas of the world, including the United States; typhus and bubonic plague are no longer the threats to our existence that they were formerly. Many similar examples could be cited.

With this background of the possible negative aspects we may speculate on what may be expected from the use of endrin for sugarcane borer control. First, we may confidently expect far more efficient and economical control than has been true in the past. For the same expenditure we will get more efficient control of two generations than has been possible for one generation.

With a more efficient, economical program more growers will adopt control of the sugarcane borer as a standard practice. Obviously our recommendations in past years have not been accepted by enough growers. Records of sales of ryania and cryolite allow rather accurate estimates of the acreage which has been treated from year to year. This has amounted to not more than 50,000 acres in any one year treated with 4 applications for control of the second generation only. One of two conclusions may be drawn from such records. Either recommendations are not adequate to obtain grower acceptance, or the pest does not cause enough damage to justify application of control measures. Since an average of about 13 per cent of the crop has been lost to sugarcane borer during the period 1935-1958, the obvious answer is that previous recommendations have not been acceptable to the majority of the growers.

Two potentially serious pests of sugarcane have been moving steadily toward the sugarcane belt. The European corn borer and the southwestern corn borer at the end of last year had both moved to within a few miles of large acreages of sugarcane. Both of these pests were found as far south as Natchitoches Parish on the west, and the European corn borer as far south as Tensas Parish on the east side of the state. At the rate they have spread since entering Louisiana, both may be expected to enter Rapides, Avoyelles and Pointe Coupee Parishes this year. How serious they will be on sugarcane is not known. Endrin is a highly effective insecticide for the control of both species. If they prove to be pests of sugarcane, an effective, proven insecticide already recommended for their use will be in use on sugarcane in a schedule of applications which would probably require no alteration for effective control of all three species.

The effectiveness of endrin has made it possible to extend the interval between applications to two weeks. This makes it possible for ground equipment to be used. With a few days leeway in application dates the problem of getting ground equipment through muddy fields is no longer nearly so acute. Use of ground machines will afford the small growers an opportunity which he has not had in the past because airplane applicators have not been interested in the 10 and 20 acre crop.

Since it is necessary for airplane swaths to be marked when granules are being applied, more uniform efficient application may be expected from airplane applicators.

More uniform growth can be expected where endrin is used. This was remarkably evident last season and results from more effective control.

Greater uniformity in growth will allow for more efficiency in harvesting and less carryover of the borer.

Endrin will prove to be especially valuable in seed increase programs. There will be no restrictions on its use on cane grown for seed and applications may be made up to harvest. In this way seed cane virtually free of borer infestation may be produced.

By using endrin for sugarcane borer control it will be possible to use canes much more susceptible to borer injury than has been possible in the past. However, this is not a sound practice and increased emphasis should be placed on borer resistance in breeding programs. Along the same line, use of endrin will permit growers to be less dependent upon cultural practices for borer control. It should be emphasized, however, that this is not a miracle working insecticide and it is strongly recommended that growers adhere rigidly to use of resistant varieties and cultural practices as an integral part of their borer control program.

Because of its effectiveness and economy, many growers will be tempted to begin a more or less "automatic" schedule of applications. It cannot be emphasized too strongly that insecticides are wasted if applied to a crop on which pests are not present in damaging numbers. Now, more than ever, growers should learn how to check their fields for borer infestation, or they should hire someone capable of doing this service for them.

Finally, it may be confidently predicted that endrin will prove to be the first of a continuing succession of new insecticides, each of which will be more effective and economical than its predecessor.

PROGRESS REPORT OF CHEMICAL WEED CONTROL IN SUGARCANE OVER THE PAST 10 YEARS

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INTRODUCTION

Considerable progress has been made during the last fifteen years in the use of chemicals as herbicides with most of the progress made in the last ten years. Sugarcane growers in Louisiana were among the first large users of 2,4-D in the United States. This chemical, 2,4-D, was recognized and made available as a herbicide in 1944. The initial use of 2,4-D in sugarcane was for the control of alligator weed, which was causing considerable trouble in the sugarcane area. Its use in sugarcane goes back about 13 years, when formulations of the commercial product were poor and the acid was very expensive as compared to the formulations and the cost of the 2,4-D today. The amine salt of 2,4-D has served the sugarcane industry well and many thousands of tons of weeds and young grasses have been killed with it. Alligator weed is no longer a problem in the sugarcane growing area, where 2,4-D has been used properly. Many miles of drainage canals and ditches have been cleared of weeds and brush by the use of 2,4-D and 2,4,5-T, a related product. Even though, 2,4-D has served the industry well as a weed killer it has also aided in creating various grass problems and these had to be overcome. It is known that the use of 2,4-D increases the growth of grass, tops and roots, as much as 30 per cent. Its continuous use in sugarcane, while eliminating some of the broadleaf plants increased grass growth. Johnson grass has been a problem in sugarcane for many years but the problem of seeds and the growth of seedlings in sugarcane was not fully recognized until about 12 years ago.

A number of people have worked with weed and grass problems in sugarcane. It is felt that continuous progress has been made and that growers have benefited from the work of all these people. The early days were spent in screening chemicals as herbicides and determining rates and dosages and their effect upon sugarcane. Approximately 100 different chemicals and formulations have been screened for their herbicidal value in the program in the past 12 years. Some of the chemicals showed promise, but cost prohibited their use when compared to other materials that were as effective in killing weeds and grasses.

The Problem of Weeds and Grasses in Sugarcane

Several factors were responsible for the build-up of serious infestations of Johnson grass, other grasses, and broadleafed weeds in sugarcane. The change from mules as the source of power to tractors was probably the largest single factor responsible for the heavy infestations of Johnson grass. Labor shortages were connected with the mechanization. There existed also the general practice of producing cheap crops without using hand labor for hoeing.

Approximately 10 years ago it was estimated that approximately one-half of the acreage in sugarcane in Louisiana was infested with Johnson grass. About 20 per cent of the acreage was so heavily infested that yields of sugarcane were seriously reduced. The problem was serious and continued to increase in severity each year.

The possibility of plowing several times during the summer to reduce the Johnson grass rhizome infestation was pointed out by individual sugarcane producers and workers of the U. S. Department of Agriculture at Houma, Louisiana. The fallow plow program, the year cane is not grown, to eliminate rhizomes was and still is an economical approach to the control of Johnson grass. The Johnson grass seedling problem in plant cane then became a serious reality after fallow plowing.

The Louisiana Agricultural Experiment Station workers have reported considerable information on Johnson grass seed. The seed are known to remain viable for a period of 8 to 10 years when they are in the soil at a depth of over 3 inches. Most of the Johnson grass seed that are produced in the cultivated sugarcane are viable and germinate about 80 to 90 per cent. Germination is best about 1 year following the production and maturation of the seeds.

The studies on seed production, longevity, and germination have played a major role in the control practices recommended to the sugarcane growers in the past 10 years. The mature Johnson grass plant has been studied in relation to its growth and the production of seeds and rhizomes. A single Johnson grass seed is capable of germinating, growing, and producing mature seeds and rhizomes nine weeks after emergence. With this knowledge, it is known that much of the fallow plowed lands could become reinfested with Johnson grass after the cane is planted in late summer.

Control of Weeds and Grasses

In 1947, studies were begun by the Louisiana Agricultural Experiment Station to obtain information for a Johnson grass control program. A search was made for chemicals, combinations of chemicals, mechanical methods, timing of application, and cultural practices. Some of the chemicals that showed promise in the beginning of the work in 1948 are still in use by sugarcane growers in Louisiana. Among these are T.C.A. (trichloroacetate) and 2,4-D the Amine formulation of (2,4-Dichlorophenoxyacetic acid).

Among the better methods of controlling Johnson grass seedlings was a post-emergence application of 2,4-D followed by flame cultivation. The timing was critical and consist of two operations approximately one week apart. There was also considerable injury to plant cane with the flame cultivation. The refined oils and fortified oils showed promise in grass control but were apt to be toxic to sugarcane. The application of these oils was difficult and they never gained a place in the control program.

As information accumulated, it was published in the Sugar Bulletin, distributed as mimeographed material by County Agents, and the Louisiana Agricultural Experiment Station. The release of this information was timed to be of immediate value to those who wished to use the control practices. Over 100 publications, both mimeographed and printed, have been written in the past 10 years on weed and grass control in sugarcane and related fields.

In 1951, the first suggestions for trial applications of TCA for Johnson grass seedling control were made. The recommendation for the use of TCA in stubble cane immediately after shaving and off-barring was also made. The basic program has not changed, and TCA is still an effective material for Johnson grass seedling and rhizome control when properly used. It was realized 9 years ago that the program was not an ideal one but it was the best that could be offered.

Since 1950 the author has appeared at night meetings and Field Days held in the 18 sugar producing parishes of Louisiana and talked about methods of weed and grass control to approximately 4000 owners, managers, overseers and people interested in sugarcane production annually. The growers that have followed the recommendations have made gains in controlling Johnson grass and increasing sugarcane yields at less cost than was originally spent for hand hoeing. The control of weeds and grass makes possible better cultivation, increased efficiency and utilization of fertilizers and aids in drainage.

A survey made in 1955 with the cooperation of the County Agents in the sugar-belt showed that about 75 per cent of the sugarcane acreage was treated with some chemical for weed and grass control. This figure has probably not changed since 1955 but it is believed that better applications are being made with the chemicals, resulting in better grass control.

In 1955, dalapon was introduced and trials were started to try to use it in stubble sugarcane. It was realized early that dalapon was a good chemical and was capable of being used if methods and proper dosage rates could be determined. Some varieties of sugarcane could not tolerate rates of dalapon required to kill Johnson grass, others tolerated the chemical much better.

Dalapon was recommended for use on the varieties C.P. 36-105 and C.P. 44-101 in 1956. Injury to cane was evident in all cases when 6 pounds or over were used on the drill. Better results were obtained with dalapon when applied following an early application of 11 pounds of TCA when the stubble was shaved and off-barred than when dalapon alone was used.

Two applications of 2 pounds each application of dalapon in plant cane consistently injured all varieties of sugarcane. Under extreme grassy or emergency conditions 2 pounds of dalapon directed on the grass and at the base of plant cane has shown promise as a late season application.

The three way combination of TCA, dalapon and 2,4-D was recognized and introduced to the sugarcane growers in 1958 for trial. This combination has shown promise in stubble cane at rates of 7 pounds TCA, 2 pounds dalapon and 1 pound 2,4-D per acre applied on the drill. The application should be made when the Johnson grass is not over 10 inches high. The application should be made at the time or immediately following fertilizing of the sugarcane.

The three way combination is equally effective in not shaved plant cane or plant cane that has been shaved early and seedlings have germinated before off-barring. This combination in plant cane consists of 2 pounds TCA, 1 pound dalapon and 1 pound 2,4-D per acre applied on the drill. Two applications are necessary in plant cane, the second application being applied after the cane is fertilized.

If tievines are a problem, one application of 3/4 pound to 1-1/2 pound of 2,4-D can be applied by airplane in August. The application should be made after the vines are growing. The use of 2,4-D for tievine control is the same for plant and stubble cane.

IMPROVING MILL DRAINAGE WITH MESSCHAERT GROOVING

Charles M. Avrill

In 1954 Sterling Sugars, Inc. grooved the back rolls of Mills No. 1 and No. 2 with Messchaert grooves and installed Messchaert groove fingers of 1/4" X 1-1/4" mild steel flats on the bottom roll scraper blades.

Messchaert grooves on the back rolls of mills are not new, and have been in use for some time. However, I do believe that the method of installing fingers has a lot to do with good operation and drainage of the Messchaert grooves.

The Messchaert groove fingers are bolted to the bottom roll scarper blades. The scraper blades have machined slots cut 9/32" wide X 5/16" deep across the back of scraper blade. These slots act as guides for the fingers. Slots are spaced to suit Messchaert grooves cut in the back rolls. The following procedure is used to hold the fingers to the scraper blade. A bar 5/8" thick x 3" wide, with slots cut 1/4" deep and the length of scraper blade, with slots in bar to match slots in scraper blade, and 5/8" stud bolt holes are drilled and tapped in scraper blade to hold down two fingers each.

During the 1954 season we experienced some trouble with the mild steel fingers. Material was too soft and some fingers bent and broke due to tramp iron and other causes. We did increase our normal juice extraction to 73.19 as compared to previous extractions of 69.07 in 1952 and 70.66 in 1953.

In 1955 we grooved all of our back rolls in all mills with Messchaert grooves. On the 1-1/4" pitch grooving we spaced our fingers on 3-3/4" centers and on the 1" and 3/4" grooving, spacing is 3" centers. Instead of the 1/4" x 1-1/4" mild steel fingers, we went to a tool steel, namely Atlantic No. 33, of the same size.

During the crops of 1955, 1956, 1957, and 1958 we did not have any trouble with the tool steel fingers, except from tramp iron in the mill. Our normal juice extraction was again increased to 75.28 in 1955, 75.85 in 1956, 72.04 in 1957 (poor weather conditions), and 77.12 in 1958. Maceration water was also increased from 15.41% in previous years to 22.33% and 23.80%.

In closing, our experience with Messchaert grooves on the back rolls has been increased normal juice extraction, increased percentage of maceration water, and a reduction of 1% to 2% moisture in bagasse. We have had fingers last one crop without replacing any.

MORE EFFECTIVE CLARIFICATION

M. M. Moron[1] and Arthur G. Keller[2]

General:

This will be a report on laboratory studies followed by plant scale evaluation of a flocculating agent now designated as Separan AP-30. The laboratory studies were carried out during the 1957 crop at the Audubon Sugar Factory, Louisiana State University. The plant scale tests were conducted at the Iberia Sugar Factory, New Iberia, Louisiana.

Iberia has two multitray center feed, peripheral overflow continuous clarifiers of approximately the same size and capacity. The clarifier station is equipped so that the hot limed juice from the heaters flows to a weir or "splitter" box where the flow may be divided between the two units. There is provision for the addition of flocculants to the hot limed juice as it flows from the box to each clarifier.

Introduction:

In the production of sugar from the juices of the sugar cane one of the most important steps is the elimination from the turbid juices of a maximum percentage of the nonsugar solids by a clarification process. This customarily involves pH adjustment with a calcium hydroxide slurry, heating to the boiling point, and separation of the flocculated nonsugar materials in batch or continuous settlers or clarifiers. The clear effluent continues in the process. The underflow or "mud" is treated chemically and filtered in batch or continuous filters. The filtrate is recycled to the entering raw juice stream while the filter cake is discarded.

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Criteria for judging the efficiency of the clarification process are numerous, but for the most part are subjective rather than objective in nature. In general, the following may be considered as the most important criteria:

1. The most rapid settling rate is the most desirable, other factors being equal.
2. The smallest % volume of sediment or "mud" and the greatest % volume of clear liquid are most desirable, other things being equal.
3. Maximum clarity consistent with rapid settling and minimum "mud" volume is the optimum combination other things being equal.
4. Minimum of unfavorable effects on the subsequent recovery of sucrose (sugar) for the clarified juice is essential.
5. Maximum elimination of nonsugar solids consistent with the criteria listed in #3 is desirable.

The comparison of a series of flocculants to determine their effect of clarification efficiency is complicated by the wide variations in composition of cane juice from one moment to the next in the course of normal operation of a given factory. Such variations may be caused by changes in cane composition from one variety of cane to another, changes in composition in the same variety from one lot to another. The changes may be caused by variations in the soil on which the cane was grown, variations in maturity, method of harvesting or varying amounts of extraneous matter in the cane delivery. Since variations in juice quality may be so great, they frequently overshadow the effect of coagulants added to the juice.

To compare the effects of several coagulants on the clarification step, all tests in a series should be made on portions of the same lot of juice. In this way the effects noted can be ascribed with reasonable certainty to the specific reagents employed. This technique is not practical for large scale tests but does greatly facilitate laboratory studies intended to assist in screening a series of compounds, treatment levels or methods of treatment.

The Problem:

A group of ten coagulants was submitted for evaluation as clarification adjuncts in cane sugar production. The effectiveness of each material as compared to the standard procedure which employs calcium hydroxide was required. It was also necessary to determine the most effective treatment level, and the place and method of addition to the system. The possible economic advantages of the various materials compared to lime, if any, was to be estimated.

Procedure:

A procedure and equipment developed in this laboratory have been employed for a number of years for laboratory study of the cane juice clarification operation. Laboratory tests correlate reasonably well with plant scale results using batch settling tanks. Laboratory data gives a reliable indication of results which may be expected with continuous settlers.

The laboratory procedure permits measurement of settling rate, volume of precipitated material, clarity of the supernatant liquor and change in "purity" as a result of the treatment. Details of the procedure will be found in Appendix "A."

Preliminary studies were made to determine whether the individual flocculants alone would satisfactorily clarify cane juice. In this study the cold raw juice was treated with the desired amount of flocculant and stirred gently to insure thorough mixing. It was then heated to incipient boiling after which the juice was poured into one of the 1000 ml. cylinders and allowed to stand 30 minutes. Good clarification and rapid settling resulted. Similar results were obtained when untreated raw juice was subjected to the same procedure.

Another series of tests were made using a flocculant to determine whether the reagent should be added before or after heating. The effect of violent agitation or turbulence after its addition was studied.

Based on the results of this series of tests, all additions of flocculants were made after the limed juice had reached a temperature of 210°F. Mixing the reagent and hot juice was by gentle agitation with a stirring rod to reduce floc destruction to a minimum.

A series of tests were conducted with each of the ten coagulants which will be designated as A, B, C, D, E, etc.

All materials were tested at cold juice pH values of 6.8, 7.4, and 7.8. Treatments were at the rate of 3, 6, and 10 ppm of the reagent on a dry basis. In each case the practice employed was that described in Appendix "A."

The results of the series of tests were summarized and are submitted in Table I which appears on the next page.

Based on the results of this study, it was decided to field test coagulant H during the 1959 grinding season. Arrangements were made to do this work on a co-operative basis with the Iberia Sugar Co-operative.

Field Test Results:

Field tests were started on November 20 and were continued through the end of the grinding season. The general plan of the study follows.

It was decided to split the juice feed between the two clarifiers. The juice going to one unit was to be treated with Separan AP-30 at the rate of approximately 6 ppm on the weight of cane ground, using a solution of 0.025% concentration of the material in water.

The information listed below was collected at two-hour intervals throughout the test period:

1. Number of dirty valves (DV) on each clarifier.
2. Number of hours during which "mud" was drawn from the clarifier (HD).
3. Number of rotary vacuum filters in operation and hours operated.
4. Time required for 100 ml of the hot limed juice (untreated) to settle to a total "mud" volume of 20 ml.

Table I. Comparison of Performance - Coagulants Vs. Lime Only.

Coagulant	6.8 pH Series						7.4 pH Series						7.8 pH Series						Total Scores		
	Mud Volume			Trans-mission			Mud Volume			Trans-mission			Mud Volume			Trans-mission					
Dosage, ppm	3	6	10	3	6	10	3	6	10	3	6	10	3	6	10	3	6	10	Mud Volume	Light Trans.	Total
A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	9	9	18
B	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	7	9	16
C	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	8	9	17
D	-	-	-	-	-	+	-	-	-	-	+	+	-	+	+	-	-	-	2	3	5
E	-	-	-	+	+	+	-	-	-	+	+	+	-	+	+	+	+	-	2	8	10
F	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	9	7	16
G	-	-	+	-	-	+	-	-	-	-	-	-	+	+	+	-	-	-	4	1	5
H	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	9	9	18
I	+	+	+	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	6	9	15
J	-	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	-	0	8	8

NOTE -- A plus sign indicates that the mud volume was less, or light transmission higher than with the same juice when treated with lime only. A negative sign indicates that the coagulant was less effective than lime only.

5. Time required for 100 ml. of the hot limed juice treated with Separan, and collected at the same time to settle to a total "mud" volume of 20 ml.

6. Pol in filter cake.

It is common practice to check clarifier mud levels by testing the try cocks on the thickening compartment of the unit. Levels are normally held as low as possible while still drawing a reasonably well thickened underflow or mud. In the table the levels are indicated as "DV" the number of cocks starting at the bottom in which "mud" or dirty juice was encountered.

At Iberia thickened "muds" are withdrawn from the settlers by gravity. The number of hours this discharge valve was open per shift was reported and appears in the tables as "HD." Obviously the fewer hours during which "mud" is withdrawn the less volume of "mud" there must have been produced.

Since the flocculant was added in the "splitter" box at the clarifier, it was possible to collect simultaneously samples of juice with and without flocculant. Laboratory settling tests were made on these samples and are reported as "Settling Time, Minutes." This is the time required for 100 ml. of liquid to separate into 80 ml. of supernatant liquid and 20 ml. of "mud." The greater the time necessary the slower is the settling rate.

It was soon evident that concentrations of 6 ppm of flocculant were excessive and the dosage was reduced to approximately two parts per million.

The results obtained when operating one clarifier on juice treated with lime only and the other on lime plus Separan are submitted in Table II.

Table II. Clarifier Performance Comparative.

	Treated Juices			No Treatment of Juice			Filter Station	
Date	D.V.	Hours Drawing	Settling* Time, Min.	D.V.	Hours Drawing	Settling* Time, Min.	Hours Operating	% Sucrose
11/24/58	21	6.5	29.4	25	7.0	38.5	24.0	4.15
11/25/58	28	12.0	36.3	22	10.0	39.0	22.5	4.18
11/26/58	36	11.5	35.8	38	12.5	44.3	24.0	4.05
11/27/58	20	9.5	27.8	20	10.5	43.7	19.0	4.00
11/28/58	20	12.0	48.3	22	12.0	62.3	24.0	3.54
11/29/58	19	10.0	23.3	21	11.0	32.3	21.0	2.50
Averages:	24.0	10.3	33.5	24.7	10.5	43.4	22.4	3.74

*Time required for 100 ml juice to settle to 20 ml "mud."

The numbers in the several columns represent twenty-four hour totals, with the exception of the column, % sucrose in filter cake. Since all are on a comparable basis totals will serve as well as actual times or volumes. It is interesting to note that % sucrose in filter cake declined from 4.15% to 2.50% during this one week run. There was no substantial difference in the number of dirty valves on the two clarifiers nor in the number of hours during which underflow was withdrawn.

Juice clarity was much better when Separan was used. Muds were more compact. Particularly noticeable was the difference in settling time of the treated versus the untreated juice. The treated juices reached the 20 ml. "mud" volume in 77.19% of the time needed for the untreated juice.

The results were so outstandingly favorable that both clarifiers were fed with treated juices for the next two weeks. The treatment level was at the rate of 1.25 ppm or about 2.5 lbs. per 1000 tons of cane ground. Data accumulated during this period which extended from December first through December 15, appear in Table III.

As would be expected, mud levels and hours drawing mud were about the same in the two machines. The sucrose in filter mud was much lower than formerly because of the concentration of the clarifier underflow. Spot samples were checked for moisture content. An average value of 68.57% moisture was measured. This, compared to the % moisture in filter cake at Iberia of 62.76% for the season, will furnish some idea of how concentrated the "mud" was.

Table III. Clarifiers Operating on Treated Juices.

Date	Clarifier No. 1		Clarifier No. 2		Settling Time		Filter Station	
	D.V.	H.D.	D.V.	H.D.	Treated	Untreated	Hrs. Operated	% Sucrose
12/1/58	12	10.0	12	10.0	18.7	37.4	22.0	2.73
12/2/58	28	12.0	30	12.0	21.3	42.1	24.0	2.13
12/3/58	30	12.0	26	12.0	21.9	44.3	24.0	1.88
12/4/58	24	11.0	21	11.0	16.8	37.3	22.0	2.13
12/5/58	36	11.5	33	11.5	22.5	50.0	36.0*	2.73
12/6/58	28	12.0	24	12.0	18.0	41.0	24.0	2.78
12/7/58	24	11.0	22	11.0	20.5	54.0	24.0	2.90
12/8/58	23	12.0	23	12.0	18.0	45.0	24.0	2.68
12/9/58	15	11.0	15	11.0	17.7	44.8	20.0	2.98
12/10/58	24	12.0	26	12.0	24.9	57.0	24.0	3.23
12/11/58	22	6.5	24	6.5	24.0	58.6	19.0	2.77
12/12/58	60	14.0	40	10.0	18.5	68.4	24.0	2.65
12/13/58	43	12.0	40	12.0	23.0	57.0	24.0	2.85
Averages:	28.4	11.3	25.8	11.0	20.4	49.1	23.9	2.65

*2 filters in service

Settling times were determined on samples taken simultaneously of juice which had received lime only in comparison to the other juice which had reached lime plus Separan. For the two-week period the Separan treated juices settled to a 20.ml. mud volume in 41.55% of the time needed to reach this volume with lime only. Roughly, the flocculant jumped settling rates almost 250% over lime only as a coagulant.

Some comparative operating statistics on the Iberia Factory for the past season appear in Table IV.

Table IV. Comparative Operating Statistics.

Period	10/20/58 thru 11/22/58	11/24/58 thru 11/30/58	12/1/58 thru 12/15/58
Cane Ground Tons/Hour	110.96	118.67	119.39
Filter Cake % Pol in Cake	4.07	3.63	2.65
Pol Loss in Cake % Cane	0.096	0.096	0.060
Undetermined Losses % Cane	0.061	0.028	0.057

Grinding rates increased as the crop progressed and the clarifiers were processing larger volumes of juices after the tests started, than they had been doing previously.

The % pol (sucrose) in filter cake declined after the tests started, probably as a result of the production of a more concentrated mud which had to be diluted in order to pump it. The muds handled well on the filters and washed very satisfactorily.

Losses of sucrose in filter cake % cane declined while losses from undetermined causes also diminished slightly.

Filtration tests made by the laboratory of one of the sugar refineries on composite samples of raw sugar produced prior to the Separan tests were compared to those made by the same laboratory on composite samples of sugar made from Separan treated juices showed equally favorable results. On duplicate tests, using ten pound sugar samples, the sugar made from Separan treated juices showed an increase of 77.6% over the rate of sugar made prior to the test when only lime was used. Since conditions were not the same during the respective periods, the higher filtration rate may be due to other causes, but it is felt that the flocculant did play an important role since sugar produced during the test period was lighter in color, cleaner, and generally of better quality than the previous production.

Summary:

Based on a careful laboratory screening study, Separan AP-30 was selected as the most promising of a group of flocculating agents under investigation.

Factory scale tests of this material indicate that it is very effective at extremely low concentrations (1.25 ppm) in improving flocculation and settling of juices when compared with the conventional lime treatment.

Settling rates were increased, mud volumes were reduced and the resulting mud was more readily thickened. Muds filtered well and % sucrose in filter cake and pol loss in filter cake % cane were reduced substantially.

The limited evidence available seems to indicate that sugars produced from Separan treated juices have a substantially higher filtration rate than sugars produced at the same factory when using simple lime clarification.

Acknowledgment:

Our thanks are extended to Mr. Fred L. Gayle who did much of the preliminary laboratory work. To the Dow Chemical Company for permission to use some of the results of work done for them by L.S.U., and to the Iberia Sugar Co-operative, Inc., for their participation in this program.

APPENDIX "A"

Procedure: Sedimentation Tests on Sugarcane Juice.

Equipment:

All settling tests are conducted in 1000 ml. Pyrex cylinders which are 6 cm. in diameter by 45 cm. in height. To minimize the disturbing effect of convection currents, the stoppered cylinders are placed in an artificially lighted cabinet, one side of which is closed by sheet glass. Five cylinders can be accommodated at one time.

Factors which may affect settling rate, volume of sediment, clarity and purity rise of a given juice sample include: (a) Nature and dosage of chemicals added to the juice; (b) pH of the treated juice; (c) rate and amount of stirring after treatment and during the heating period; (d) point in process at which chemical is added; and (e) method of heating and final temperature before settling. In a given series of tests as many of these variables as possible are held constant.

For a comparison of flocculating agents, (c), (d), and (e) above are held constant. A series of tests are conducted with each flocculant using three dosage levels and three pH values. In every series, check tests were made on a portion of the same juice with lime only as the chemical agent. Treatment levels are established by a series of preliminary tests. pH values are within the commercial range employed in Louisiana practice.

The standard procedure employed in this study follows. A quantity of juice sufficient for a series of twelve settling tests is collected from the factory supply and held under refrigeration until used. Twelve tests constitute a series.

Measured volumes of a well mixed juice are poured into each of twelve 1500 ml. Pyrex beakers. To each lot of juice there is added a sufficient amount of 5° Baume calcium hydroxide slurry (about 4.5% CaO) to bring the pH to the desired value. The juice is stirred during lime addition with an electric laboratory stirrer operating at 1800 rpm. pH values are determined with a Beckman Model H-2 pH meter.

After final pH adjustment the beakers are transferred to an electric hot plate and their contents heated to 210°F. The selected flocculant is added at the selected dosage. The solutions or suspensions were added from a pipette while slowly stirring the contents of the beaker with a glass rod. Heating is then continued to incipient boiling (about 212°F).

The contents of the beaker are poured immediately into a 1000 ml. graduated cylinder located in the settling cabinet. A stopper or cover is placed over the end of the cylinder to reduce heat loss.

At the end of 30 minutes the volume of precipitate is noted and recorded. A sample of the supernatant liquid is removed and its light transmission and pH values are measured.

The Beckman Model C Colorimeter is employed to measure the transmittancy of the clarified juice sample. Transmission is measured over the range of 350-660 millimicrons.

A comparison of volume of sediment, and transmittancy as compared to the check sample which was treated with lime only gives an indication of the relative merits of the flocculant under examination.

CARY HARVESTER COMBINE

Charles Savoie, Engineer
Lula Factory

In 1957 the Trash and Cane Handling Committee of the American Sugar Cane League examined the plans for a cane combine drawn up by the Cary Iron Works, Inc. of Opelousas, Louisiana, and went on record to the effect that the plans merited the construction and testing of a prototype machine, Members of that committee are: Messrs. Roland Toups, John Best, Robert Coleman, Mansel Mayeaux, Eugene Graugnard and Charles Savoie.

Since Cary Iron Works stated that their company was not able to completely finance the building and testing of a prototype machine, all Louisiana sugar cane processors were given an opportunity toward the financing. Twenty (20) processors contributed funds toward the project which were disbursed by the Trash and Cane Handling Committee of the League in accordance with an agreement signet by the cooperating processors, Cary Iron Works, and the Trash and Handling Committee.

Following are some statistics and comments of the Cary Harvester while in operation at the Lula Factory during the 1958 Harvest Season.

All of these figures and comments are taken from the operation of the harvester before any major changes were made on the machine.

Mr. Scheafer will later discuss the changes made and the results of these changes.

Table I shows the tonnage cut and cleaned by the Cary harvester during the 1958 harvest season at Lula Factory.

TABLE I - Cary Combine

DATE	TONS	% TRASH
Oct. 30	3,000	
Oct. 30	3,000	
Oct. 31	3,280	
Nov. 1	3,810	
Nov. 4	7,120	
Nov. 5	1,800	
Nov. 6	15,750	8.19
Nov. 7	23,430	9.09
Nov. 10	30,250	8.03
Nov. 11	61,360	10.89
Nov. 12	60,720	9.51
Nov. 13	104,850	6.93
Nov. 14	75,770	11.93
Nov. 15	14,310	5.30
Nov. 18	87,430	7.09
Nov. 19	80,080	10.01
Nov. 20	37,340	10.06
Nov. 21	105,130	9.24
Nov. 23	20,600	11.46
Nov. 24	64,250	10.91
Nov. 25	47,340	8.31
Nov. 26	79,050	7.63
Nov. 27	48,140	7.58
Nov. 28	41,680	10.00
Dec. 1	79,620	8.16
Dec. 2	96,640	9.30
Dec. 3	30,710	8.46
	1,223,460	

TABLE II

Variety - 310 Lula Plantation

	Conventional Harvester burned & loaded	Cary Harvester
Gross	37.57	39.89
Net	34.47	35.82
Standard	31.57	28.20
% Trash	8.24	11.46
Sucrose	10.99	10.39
Purity	75.50	73.31

Table II shows a comparison test of cane cut by a conventional harvester, burned and loaded and the same variety cut, cleaned and loaded with the Cary Harvester.

Table III shows an approximation of the amount of cane that was left in the field after being picked up and cut by the Cary Harvester.

We picked rows at random, weighed the cane left in the row and weighed the cane in the wagon taken from the respective rows.

TABLE III

Cane in Wagon	7,000 lbs.
Cane in field	200 lbs
Total cane in row	7,200 lbs.

% Cane left in field 3.6%

Assuming 28 tons/acre this would be 1 ton left in field.

With reference to the results shown in Table II, of tests taken from the chopped cane harvested by the Cary Combine and tests taken from whole cane harvested with the conventional harvester, these results although compared in the table do not give a true picture because the whole cane is burned and allowed to stay in the field for some time, which causes some drying out of the cane which in turn makes the percent sucrose rise. Also, the whole cane taken from the trucks and wagons are pulled out of the bundle stripping most of the leaves from the stalk. This gives a well distributed sample of the day's haul, as nearly all loads are sampled, but is not representative of each bundle. Whereas the chopped cane is taken directly from the harvester and cannot be selected, as to whole cane, but is truly representative of the cane as it comes from the field to the factory.

In relation to the trash sampling, it is rather conclusive that the conventionally harvested whole cane has less trash such as leaves than the chopped cane, but again we have a difference in sampling. The trash sample of the chopped cane is about as perfect a sample as is feasible to obtain. The trash sample of the whole conventionally harvested cane, no matter how well taken is not representative as has been proven by Dr. Keller's experiments. Although the full length cane has less leaves, it contains much dirt, which when sampling falls out before the sample is placed in the canvas. Dr. Keller's experiments and many other experiments have proven rather conclusively that the trash in whole cane is about double that shown by the tests.

The objection to the use of the combine in its present form is not indicative of the machine, but in the chopped cane. The present mill with one or two sets of knives and two roller crusher will not take as good a feed with cane chopped fourteen inch lengths as it will with full length cane. If it were not for this objection I would be ready to accept the machine as is. Further refinements would come with use of the machine.

It is still possible that the machine can cut the cane in lengths just beyond the critical length and still do a fair job. There is also the possibility of using a desiccant on standing cane and then burn it and harvest it with the combine, in lengths suitable for the mill.

THE PROBLEM OF EXCESSIVE TRASH GLENWOOD SUGAR FACTORY

Luis Suarez, Chief Engineer, Glenwood

One of the many things I learned at Glenwood in the 1957 Crop was that our trash was excessive, to such an extent that according to approximate figures it was over 15% of the cane ground.

Naturally this trash means more work for our mills. When conditions are bad it returns a considerable amount of mud, with the corresponding harmful slipping of the same.

No need to mention the considerable wear that this excessive trash can cause in our two trash and screw conveyors.

The apron Intermediate bagasse carrier that is used at Glenwood, although it has its advantages, one of the disadvantages is the amount of trash it drops, this added to the trash from the Cross and Messchaert grooves, made a most undesirable condition for our mills. To avoid trash from our intermediate carriers, we approached their nose as close as possible to our front rolls. Although this didn't stop the trash from falling, it certainly diminished the total amount we were getting from this source.

The Cross Grooves of our front rolls were made too deep and they would drop a considerable amount of trash. For the 1958 crop they were made about 2/3 the total depth of the tooth, while for the 1957 crop 7/8 the total depth. This made a considerable improvement. We didn't notice any effect in the slipping of the mills, although the grooves were not as deep. Of course, the top roll kept the usual deep groove. The change was only made on the front roll.

Although all these changes help, the one that really made an appreciative difference was our method in cleaning our Messchaert grooves.

First of all I must mention that there is nothing new about this method, not only did I use it and discharge it in three tandems in Cuba, about eighteen years ago in one case and ten years ago in the other one, but also Mr. L. A. Tromp mentions this method in his famous book and calls it: "Scraper blade in the Trash Knife."

Mr. Tromp claims that there is a heavy wear on these blades because they are not properly guided and also heavy lateral wear in the grooves, which are soon widened. I have found out by experience that this is correct and that is the reason that I discharged them in the past.

He also claims that the grooves are choked by the blades and so the juice can not drain on the knife-side of the roller, thus reducing the efficiency by 50%, as the Messchaert grooves should drain on both sides of the roller. He doesn't prove this point and I certainly can prove the opposite, but just plainly state that, as we all know, most of the juice, if not practically all, drains off through the front of the roll. On the mills it is hard to tell if any juice flows through the back, but I have repeatedly observed our Crusher, and while a considerable amount of juice flows out through the front, I haven't seen any flow through the back. If it is so that a limited amount of juice is supposed to come out through the back of the front roller, reabsorption would take place not allowing the flow of juice on top of the turn plate, but we all must admit that the bagasse out of the Messchaert Grooves brings back to the mill a great deal more juice than that which is left on the same (if any) due to the choking of the grooves.

If fingers are used under the roll it is still very doubtful that the bagasse would not choke the groove at the compression point obstructing juice drainage in the back of the feed roll.

During the 1958 crop we have ground with and without the scraper blades and have found no difference in the extraction or moisture, but we had a considerable difference in the amount of trash and in the cane ground per hour with the same equipment, speed and almost the same settings as in 1956 and 1957.

It is agreed that the benefits are to be accepted, then there is only one more thing to discuss and that is the wear of the scraper blades and the widening of the Messchaert Grooves of the roll which was the reason that stopped this practice in many sugar mills in Cuba.

At Glenwood the scraper blade was used right in the Turn plate. To avoid excessive wear of the same and mainly of the grooves, this blade was fitted properly by making a pattern out of the drawing of the mill and long enough to avoid lateral motion, that widens the grooves. The tooth of the turn plate, opposite to the Messchaert Groove was cut down to allow a wide scraper and the hook on the scraper proper was made so as not to protrude over the circular groove of the roll.

IMPROVED CANE MUD FILTRATION WITH THE ROTOBELT FILTER

E. R. Vrablik* and D. A. Dahlstrom**

INTRODUCTION

In the processing of cane to obtain sugar, a significant operation in the flow sheet is the clarification of the raw juice by settling followed by filtration of the settled mud. Ideally, it is desirable to obtain a clear overflow from the settling device and a clear filtrate from the filter unit. The latter was achieved by use of plate and frame filters but due to the high labor costs and other attendant difficulties, they are generally uneconomical. Continuous vacuum drum filters with cake washing have been substituted in order to reduce labor costs and increase productive capacity. Due to the blinding nature of the suspended solids and waxes in the settled mud, cloth type media could not be employed. Instead, the use of perforated or slotted copper plate as a filter medium, which exhibited a greater resistance to blinding, has become standard. However, this medium performs a "screening" operation on the mud. During the initial phase of cake formation an appreciable amount of suspended solids is drawn through the perforated copper plate into the filtrate. This necessitated a change in objectives in that clarified juice was taken only from the clarifier overflow and the filtrate recirculated back to the clarifier.

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The filter therefore served only as a means for removal of suspended solids and not as a clarifying tool. Modifications of the filter station have employed a "cloudy port" such that the first portion of the filtrate was recycled back to the clarifier with the second portion passed on to evaporation. Generally, this type of operation is undependable, particularly when mud conditions change, as the percentage of "cloudy filtrate" cannot be quickly changed. Thus, when a "cloudy port" operation is used, as much as 85% of the filtrate is recycled. There have also been other changes in the clarification flow sheet such as the practice of compound clarification in an attempt to improve the removal of suspended solids from the juice. This results in a further recirculation of mud with increased retention times of the juice. In addition, the filtrate must still be recirculated back to the secondary clarifier.

Recirculation of the filtrate may at first glance appear to be satisfactory, exclusive of the added retention time and additional load on the clarifier and filter. The suspended solids would simply settle out again and return to the filter in the settled mud. However, because of the screening action of the perforated copper plate, the finer solids or dispersoids may continue to build up in concentration until the settling device suffers in operation. The clarifier overflow purity is then injured and/or the clarifier underflow becomes too dilute in suspended solids concentration for effective filtration.

Accordingly, if a sufficiently clear filtrate could be achieved on a continuous vacuum filter suitable for passage to the evaporators, the following advantages could be realized.

1. Increased sugar recovery due to the reduction in sucrose inversion. Extensive inversion is caused by increased retention time at elevated temperatures.

2. Increased grinding rate of the mills by elimination of process upsets.

3. Increased productive capacity of the filter and clarifier by eliminating recirculating mud load.

4. Reduced operating costs below those presently experienced on the conventional continuous vacuum Cachaza drum filter. Undoubtedly, in addition, chemical requirements such as lime would be reduced by the elimination of the circulating mud load.

5. Improved control over the flow sheet by the possibility of liming the whole mud to the same pH filtrate as clarified juice without upsetting the controlled liming of oncoming raw juice.

6. Reduction in wash water for minimizing sucrose losses thereby lowering evaporation costs.

Additional benefits would be the reduced abrasion by the suspended solids of the internal drainage parts of the filter and the filtrate lines. This would also apply to the replacement of the perforated copper plate caused by the granular solids abraiding the metal in passing through the perforations. It has not been uncommon to replace several sections of the perforated copper plate during a campaign because of excessive wear.

From the above, it became apparent that a filtration method would have to be developed that would permit the use of fabric filter media in order to achieve suitable filtrate clarity. This necessitates the employment of relatively "tight" cloths that would eliminate the "screening" action of the perforated copper plate and thereby yield a suitable filtrate.

As these fabrics would blind almost immediately on the conventional drum filter, a new approach to continuous filtration was necessary. The development of the Eimco Rotobelt Filter offered this opportunity due to its completely new method of operation. The paper will discuss the basic principle of the Rotobelt Filter and the pilot plant results achieved on cane mud filtration at two different plants. Reference will also be made to full scale operations on other industrial applications.

ROTOBELT FILTER PRINCIPLE

Ideally, continuous filtration would be best practiced if the following features could be obtained.

1. The use of an essentially clean medium at all times. It is commonly known that elimination of blinding will always maximize filtration rate and minimize filter cake moisture content.

2. Remove the filter medium away from the drum to eliminate the possibility of blow-back of filtrate when the cake is discharged. This would be a distinct advantage in reducing sucrose losses in sugar processing.

3. Easy discharge of thin filter cakes. The thinner filter cakes are experienced at faster drum speeds and thereby increased productive filter capacity is achieved. Thinner filter cakes, due to the higher washing efficiency, will also yield higher soluble recoveries.

4. Allow rapid and easy change of filter media when necessary in order to minimize filter down time.

To incorporate these features into continuous filtration, the Rotobelt Filter was developed after considerable research and development. The basic principle is seen in Figure 1.

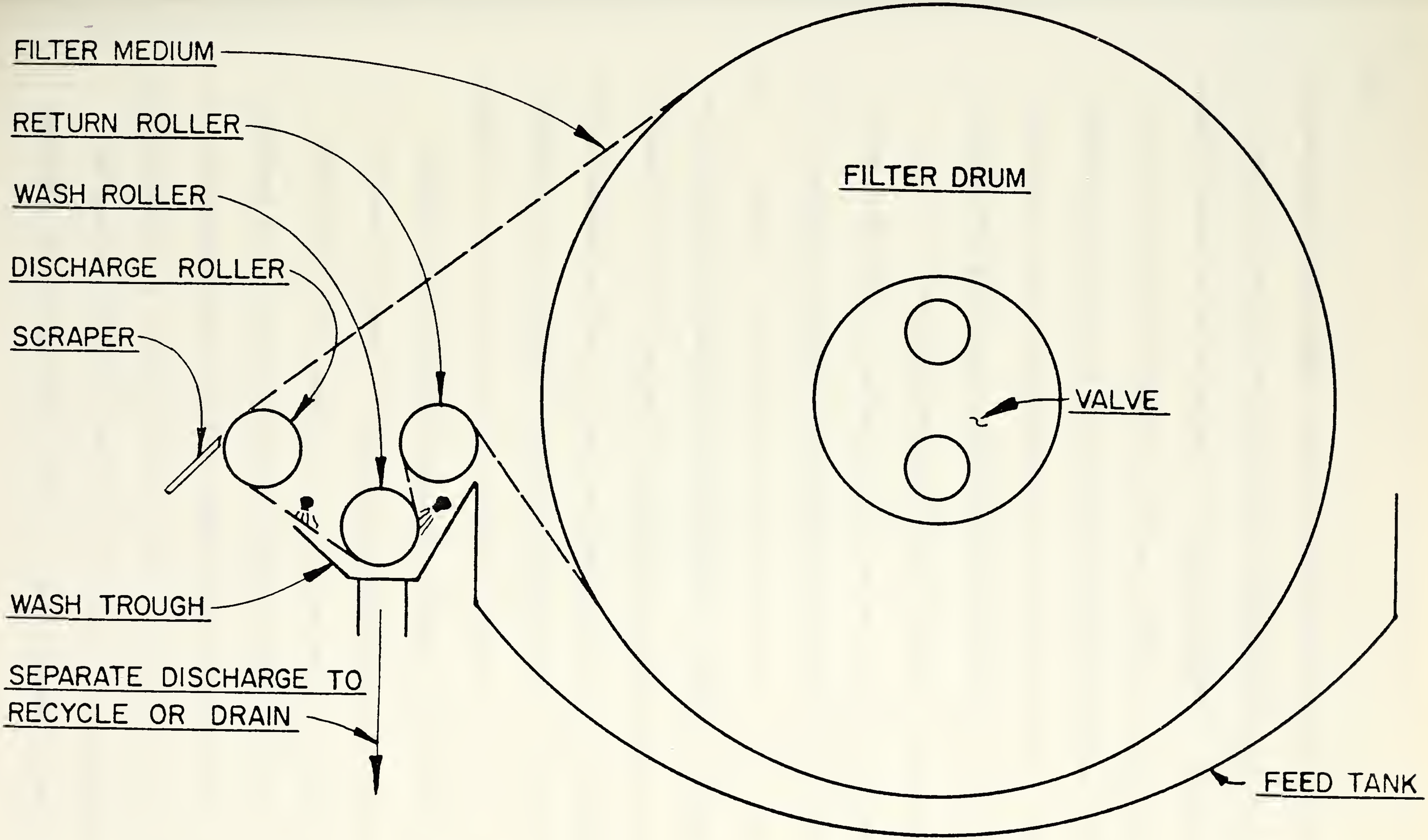

FIGURE I

BASIC PRINCIPLE OF THE ROTOBELT FILTER

The Rotobelt Filter consists of a drum, an endless belt filter medium, discharge, wash and return rollers, and a trough for collection of the medium wash liquor. The Rotobelt drum is similar to the conventional drum with the exception that the filter medium is not caulked onto the drum surface. Instead, each drum sector is separated by soft natural or synthetic rubber inserts in each division strip and around the two ends of the drum. Thus, each sector is isolated from the adjacent ones as the filter medium lays over these rubber inserts and effects a very tight seal.

The endless belt passes over a small diameter discharge roll after leaving the drum carrying away the filter cake. Both cake and filter medium experience a very severe reduction in the radii of curvature (which is different for both). Therefore the cake tends to break away from the medium thus assisting cake discharge. A scraper blade set slightly away from the medium conducts the cake away in a continuous sheet if the solids are of a texture that maintains this type of formation or as discrete lumps if the solids are granular in nature. The small diameter roll allows the blade to be set very close to the medium surface without contact, since a horizontal line across the discharge roll at the location of the scraper is equidistant from the scraper at all points as the roll rotates.

The medium is conducted under a wash roller that can be partially submerged, if desired, in a wash trough. A spray wash on either side of the medium permits thorough cleaning of each surface. If necessary, high velocity sprays can be employed for penetration into and through the medium to remove blinding within the fabric. Removed solids, together with the wash fluid, are recovered in the wash trough. The blinding tendency of the solids or liquor with the particular medium employed will dictate the extent of spray washing required. In many applications, no wash or only a periodic one is required. Where continual washing must be practiced to prevent blinding, the wash fluid can be recycled upstream as a part of the make-up water or fluid requirements as the solids concentration will be very low due to the complete cake discharge experienced. There have also been applications where the cake is sluiced off of the medium into the wash trough for discharge. In such cases, the cake was purposely repulped for further processing or discharge to waste in the desired form of the reslurred pulp.

A return roller places the medium back on the drum so as to continue the filtration step. It will be noted that all cake discharge and medium washing occurs away from the drum and filter tank. Thus, it is impossible to contaminate the cake with filtrate or the feed pulp with medium washing fluid.

Because of the tight seal between filter sectors, regulation of the drying vacuum, separation of strong and weak filtrates or any other operation performed on a conventional drum filter can also be achieved with the Rotobelt Filter. Accordingly, the Rotobelt Filter possesses the same flexibility as the former unit while exhibiting the improved advantages cited earlier.

The endless belt is kept in constant alignment by an automatic aligning roll. If the belt travels to one side or the other, a solenoid acts to reposition a split roll and thereby bring the belt back into alignment. Both the maximum distance of travel and "throw" of the roll are adjustable without stopping the filter. The maximum travel of the belt is always limited to a value such that the filter medium always extends over the drum end seals by approximately one inch or more.

The filter medium can either be of the permanent or fabric type. The former consists of a spiral woven stainless steel belt so constructed that there is no flexing of the individual strands to cause eventual fatigue of the metal. With the fabric types (practically any cloth medium can be employed), a zipper closure to make the belt endless is used. Thus, the filter medium can be changed in a matter of minutes when necessary.

Because of the sealing devices, any economical vacuum can be achieved. Vacuums of 26 to 27 inches of Mercury, which usually represents maximum economic level for "tight" cakes at standard barometric pressure and ambient temperature, have been realized when necessary. Thus, maximum pressure drop for maximum filtration rate and minimum cake moistures is achieved.

From the above, the Rotobelt Filter offers the following advantages over the conventional drum filter:

1. A clean non-blinded medium at all times to achieve maximum filtration rate and minimum cake moisture.

2. Ease of cake discharge, even with thin cakes, so that fast drum cycles can be employed to increase filtration rates further.

3. Elimination of filtrate blow-back.

4. Reduction of filter cloth wear to a minimum as scraper blade does not contact medium.

5. Severe decrease in down time for changing filter medium as no caulking or wire winding is employed.

6. Easy access to filter deck for cleaning if necessary as it is always exposed between the take-off and return point of the medium.

7. Maintenance of as high a vacuum level as desired by sealing method that prevents leakage.

8. Cake may be sluiced off filter if desired for processing reasons without contamination of the feed slurry. Some of the applications to date have been made on material that could not be continuously filtered previously. In some cases, a very "tacky" and thin cake resulted that could only be discharged by a sluicing method which would be impossible on the conventional drum filter.

9. More complete cake discharge due to the severe change in radius of curvature of the cake and medium and the possibility of setting the scraper blade very close to the cloth.

Figure 2 illustrates an 8' diameter by 6' face Rotobelt Filter after manufacture. The unit employs a stainless steel permanent medium. The small wash trough required can be seen and the low discharge point away from the drum and convenient for cake conveyance will be noted.

Figure 3 is an 8' diameter by 14' face cloth Rotobelt Filter installed in a beet sugar plant. The unit is operating on direct filtration of first carbonation juice and to the writers' knowledge is the first time this has ever been achieved successfully. The cake is discharged without a scraper blade as it is desirable to dispose of the solids to waste in a pumpable slurry formed by sluicing the cake at discharge.

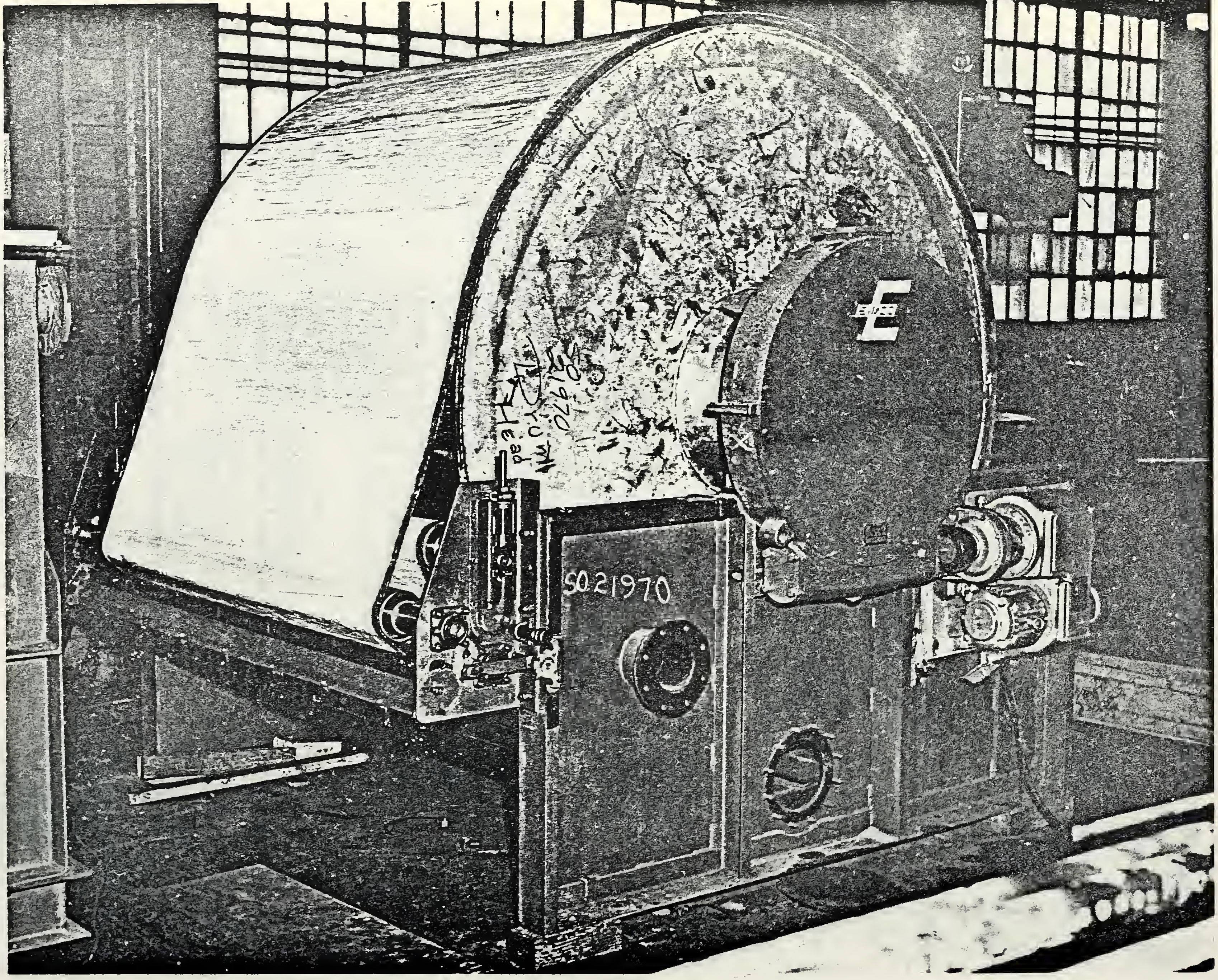

FIGURE 2

8' DIAMETER BY 6' FACE ROTOBELT FILTER

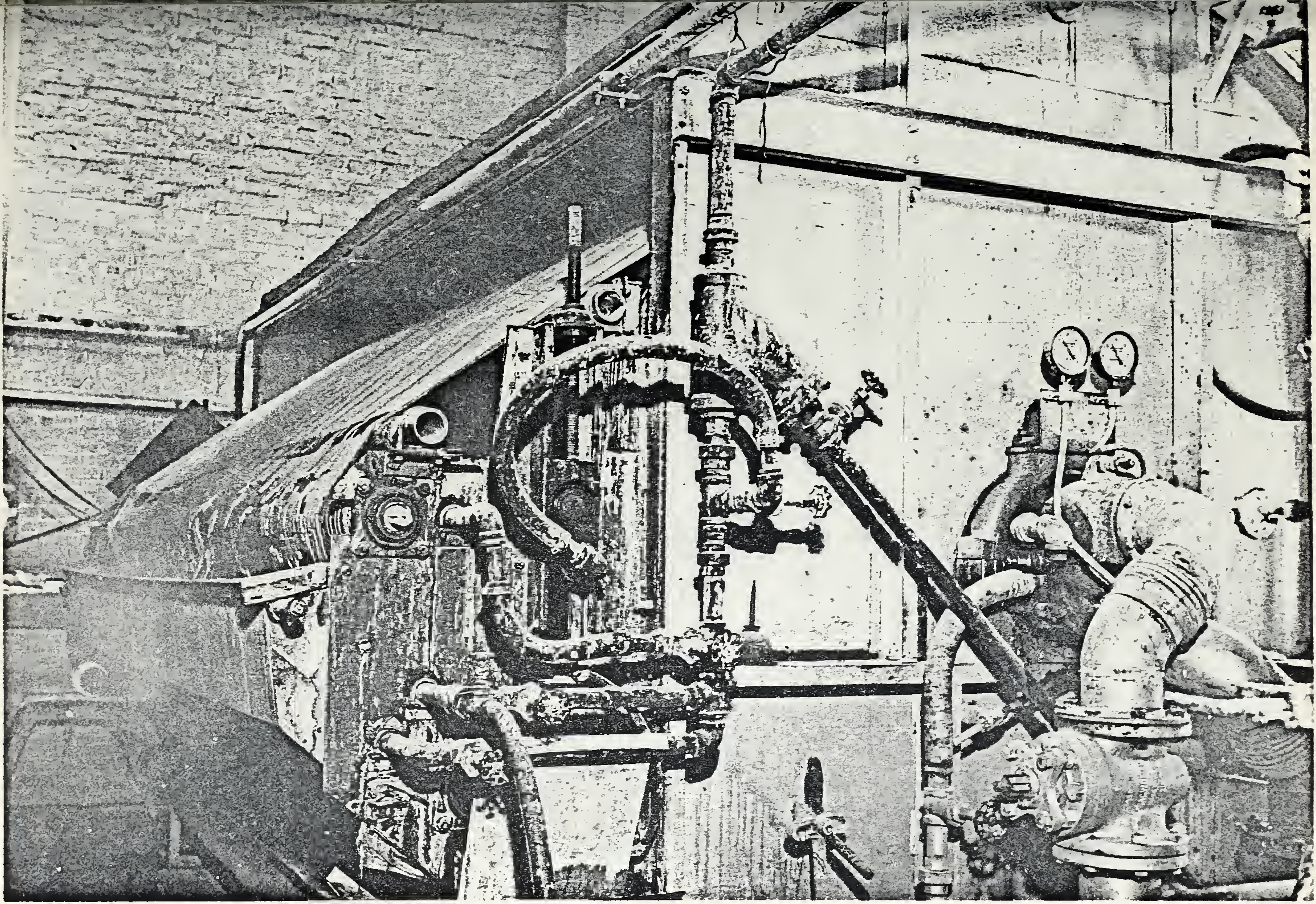

FIGURE 3

8' DIAMETER BY 14' FACE ROTOBELT FILTER

DIRECT FILTRATION OF FIRST CARBONATION JUICE

BEET SUGAR FACTORY

A close-up of the type of cake discharge obtained with the Rotobelt Filter will be seen in Figure 4 on two industrial 10' diameter by 8' face units. The sheet-like cake discharge is readily apparent with the material being filtered.

ROTOBELT FILTER PILOT PLANT TESTS ON CANE MUD FILTRATION

In the development of the Rotobelt Filter, a mobile pilot plant filter station was constructed as shown by Figure 5. It will be noted that the trailer unit is complete with all auxiliary equipment such as vacuum pump, filtrate pump, receivers, mix tanks, chemical feeders, etc. Upon moving the unit to a plant, all that was necessary to put it into operation was a power source to the starter panel, a fresh water line for seal water on the vacuum and filtrate pumps, and a feed source. During the course of the development work, 51 plants were visited throughout the United States and Canada.

Cane mud filtration studies were performed at two factories in Louisiana and Florida. Both plants practiced compound clarification on the raw juice with liming before each of the two clarifiers in series (i.e., underflow of first clarifier to second clarifier). The underflow of the secondary clarifier passes to conventional cane mud filters with perforated copper plate filter medium. However, in the case of the Florida factory, it is necessary to further lime the secondary clarifier underflow in order to achieve an operable cane mud filtration. At Louisiana, the factory would experience difficulty in filtration with "bad mud" conditions, particularly during heavy rainfalls. Thus, it was felt that both locations

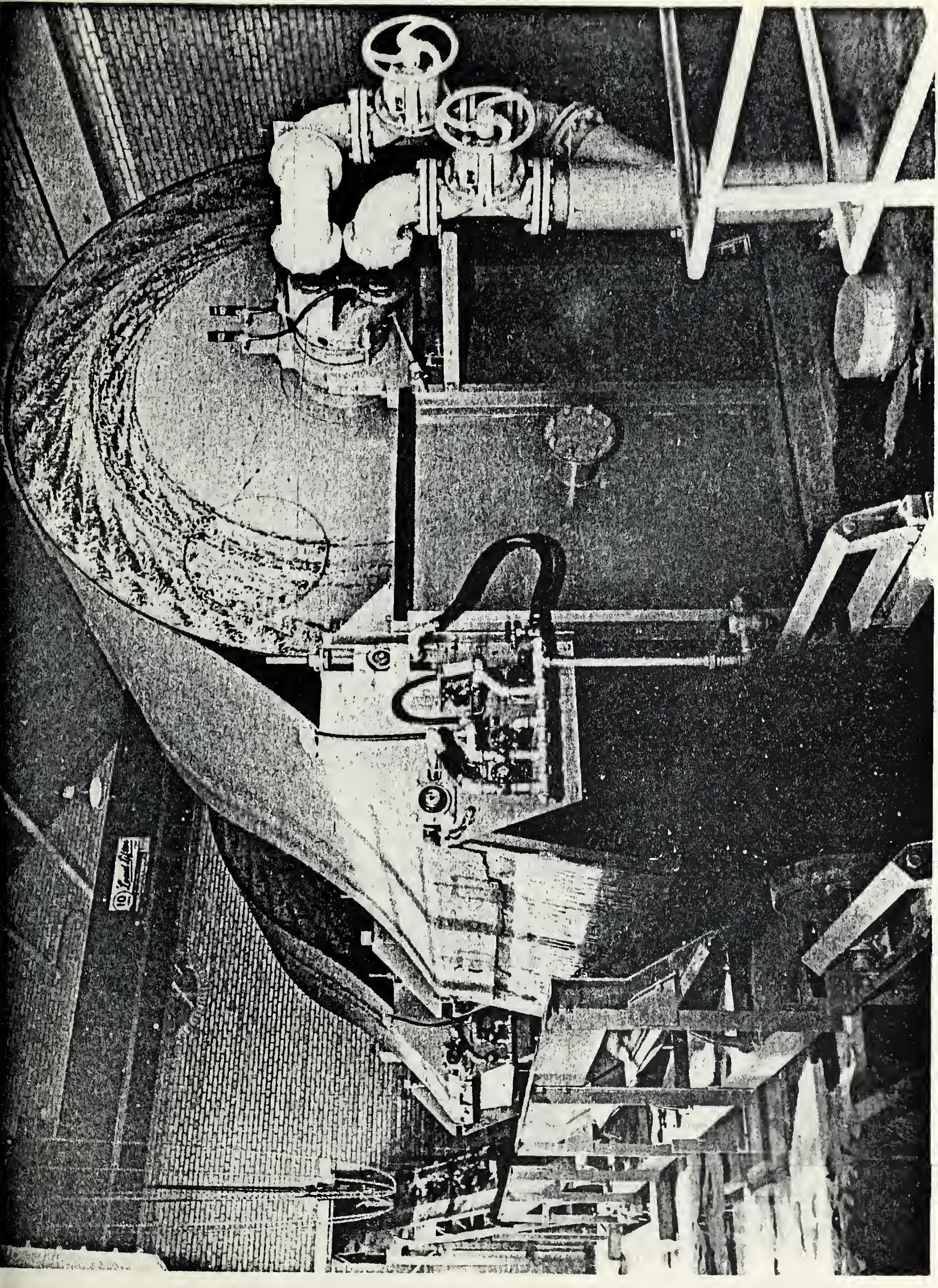

FIGURE 4

TWO 10' DIAMETER BY 8' FACE ROTOBELT FILTERS

NOTE SHEET DISCHARGE OF FILTER CAKE

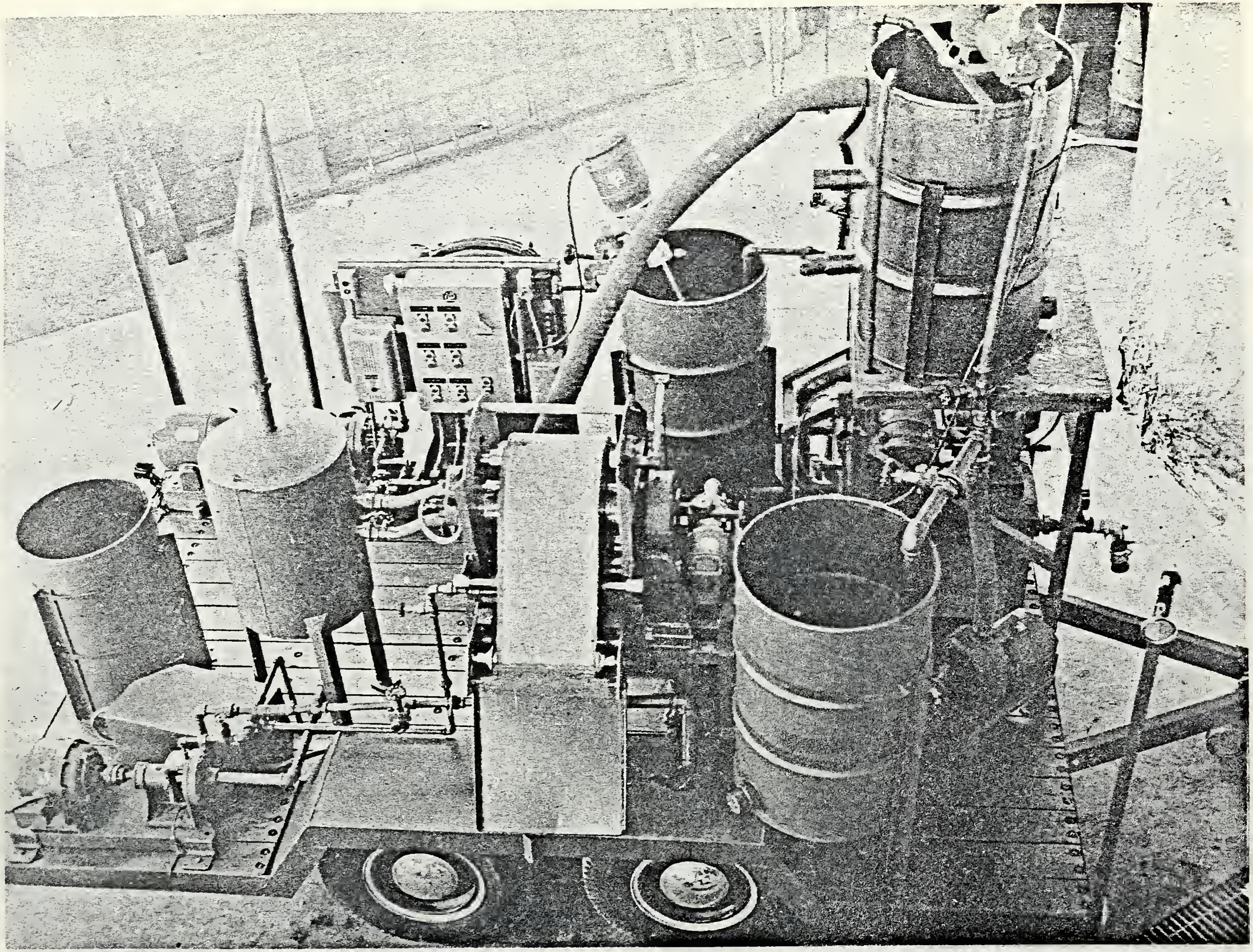

FIGURE 5

MOBILE TRAILER PILOT PLANT ROTOBELT FILTER STATION would offer a good test of the Rotobelt Filter's application to cane mud filtration.

In the studies at Florida, the major amount of work was done on secondary mud as fed to the plant filters. However, unlimed secondary clarifier underflow was employed and limed in the trailer mix tanks to the desired level for testing. Four different filter media (three nylons and one cotton) were employed on the Rotobelt pilot plant. Two of these, a 17.5 ounce cotton twill and a 13.3 ounce nylon twill were found to be most successful. It was difficult to maintain a constant feed temperature in the filter tank due to natural radiation losses. Because of the relatively large amount of radiation surface per unit volume of tank capacity compared to a full size unit, this was to be expected. Thus, a range of 10°F at one set of feed conditions was not unusual and actually to be expected. Accordingly, results should probably be poorer if anything than a full scale unit.

Figure 6 is a log-log plot of filtration rate expressed as gallons of strong filtrate per hour per square foot (exclusive of wash filtrate) as a function of filter cycle time in minutes per revolution. Parameters of the two filter media cited above are included. The mud pH is 8.5 for nylon and 7.5 for cotton. Also, the bagacillo on °Brix is considerably higher for cotton than nylon.

The nylon exhibited higher filtration rates than the cotton medium. This is caused by the difference in type of fiber and weave. The nylon is a multifilament while the cotton is a spun staple. This indicates the

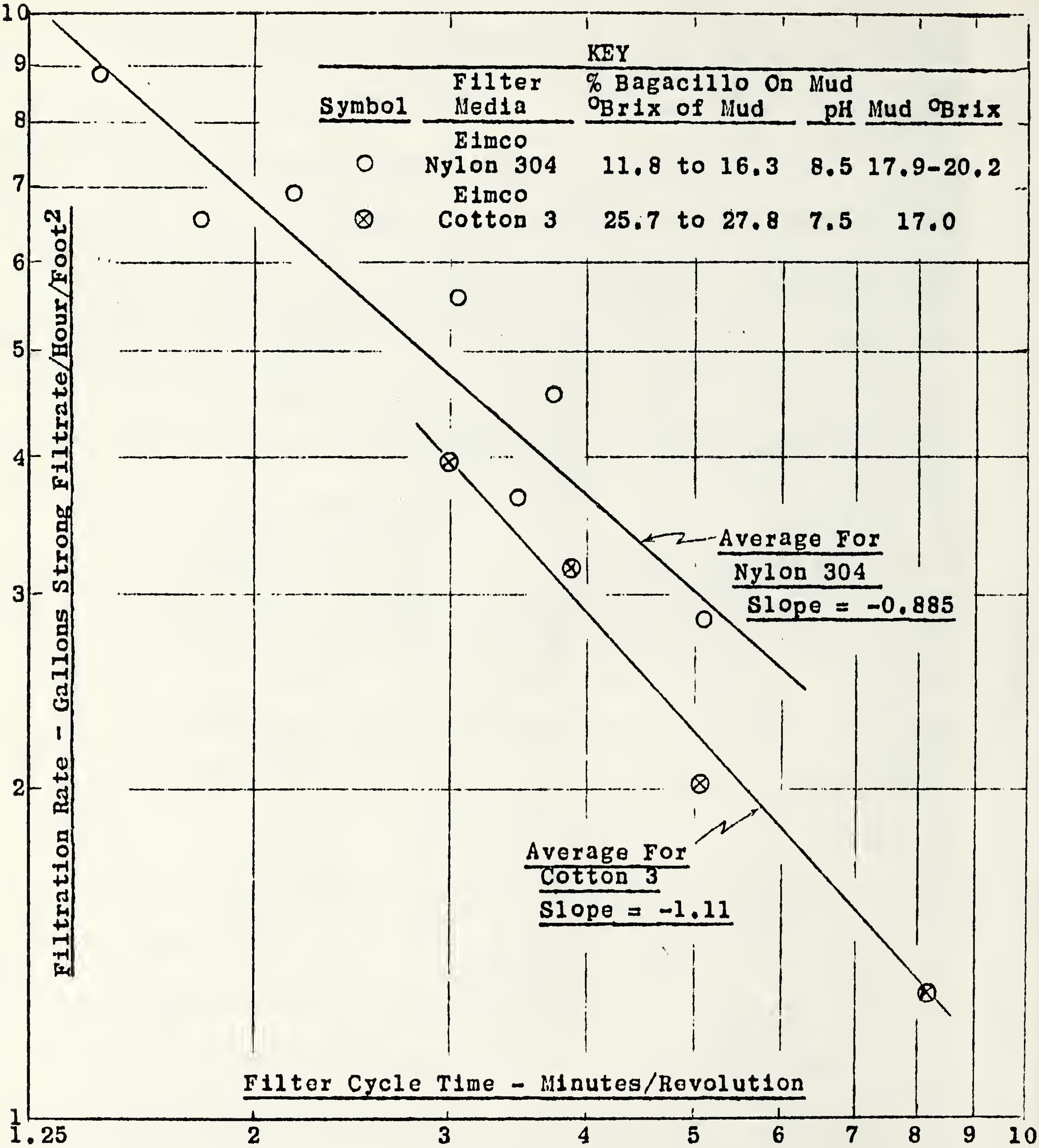

FIGURE 6

FILTRATION RATE AS A FUNCTION OF FILTER CYCLE TIME

PILOT PLANT ROTOBELT FILTER AT A FLORIDA CANE SUGAR FACTORY

BASES: Feed Temperature = 176 to 192°F
Feed Wt.% Suspended Solids = 5.32 to 7.34
Secondary Mud Feed

importance of correct filter media determination in order to achieve maximum filtration efficiency.

All other factors remaining constant, filtration rate should be a logarithmic function of filter cycle time. Thus, average straight lines have been drawn through the two sets of data. Agreement is reasonable, particularly when the variation in feed temperature is considered. It will be noted that negative slopes of -0.855 for the nylon medium and -1.11 for the cotton were experienced. The reason for the blinding that results with conventional cloth covered drum filters on cane mud is thereby explained. For normal filter feeds, negative slopes of -0.5 to -0.65 can be expected. The greater negative slopes obtained indicate that a filter cake is formed that rapidly "seals-off" further filtration by plugging of the capillaries in the filter medium and cake. Thus, relatively thin cakes are formed regardless of the length of the filter cycle. In addition, if the solids are not completely removed from the cloth, blinding eventually will result. With the Rotobelt, a constant spray wash of the cloth on both sides, which would be impossible with the conventional drum filter, was necessary. In this regard the runs on cotton were made over a period of 24 hours with no apparent blinding and duplicate results achieved.

Shorter cycle times, together with lesser amounts of bagacillo, were employed with the nylon medium. An economic advantage can therefore be realized with greater productive capacity and reduced bagacillo consumption. It should be emphasized that filter medium selection will not necessarily be the same for all cane muds. Rather, this will be a function of the nature of the suspended solids and the processing steps preceding filtration.

The pilot plant Rotobelt Filter was only operated with 25% submergence. This submergence is maximum on the 18" diameter pilot plant drum due to the relationship between drum and trunnion diameters. However, on a full scale plant filter higher submergences up to 40% could be realized without use of trunnion stuffing boxes. Naturally, this increase in submergence would permit even a higher filtration rate as shorter cycle times could be used.

To illustrate the influence of feed mud pH, a plot of filtration rate as a function of this variable is given on Figure 7. The secondary clarifier underflow at the Florida factory ranged from 6.35 to 6.7 and the filtration rate at this point is seen to be low. However, filtration rate increased rapidly with an increase in pH and then appeared to stabilize at about 9.5. Figure 7 is on the basis of the nylon medium at a constant filter cycle time of three minutes per revolution. All other variables such as bagacillo concentration, mud Brix and temperature were held relatively constant. A similar result was experienced with the cotton medium although filtration rates were always significantly below nylon at the same pH level.

In the actual plant operations, higher pH and lime dosage were necessary to achieve effective filtration with the conventional drum filters. Thus, it would appear that economic savings could also be realized in lime consumption by use of the Rotobelt Filter.

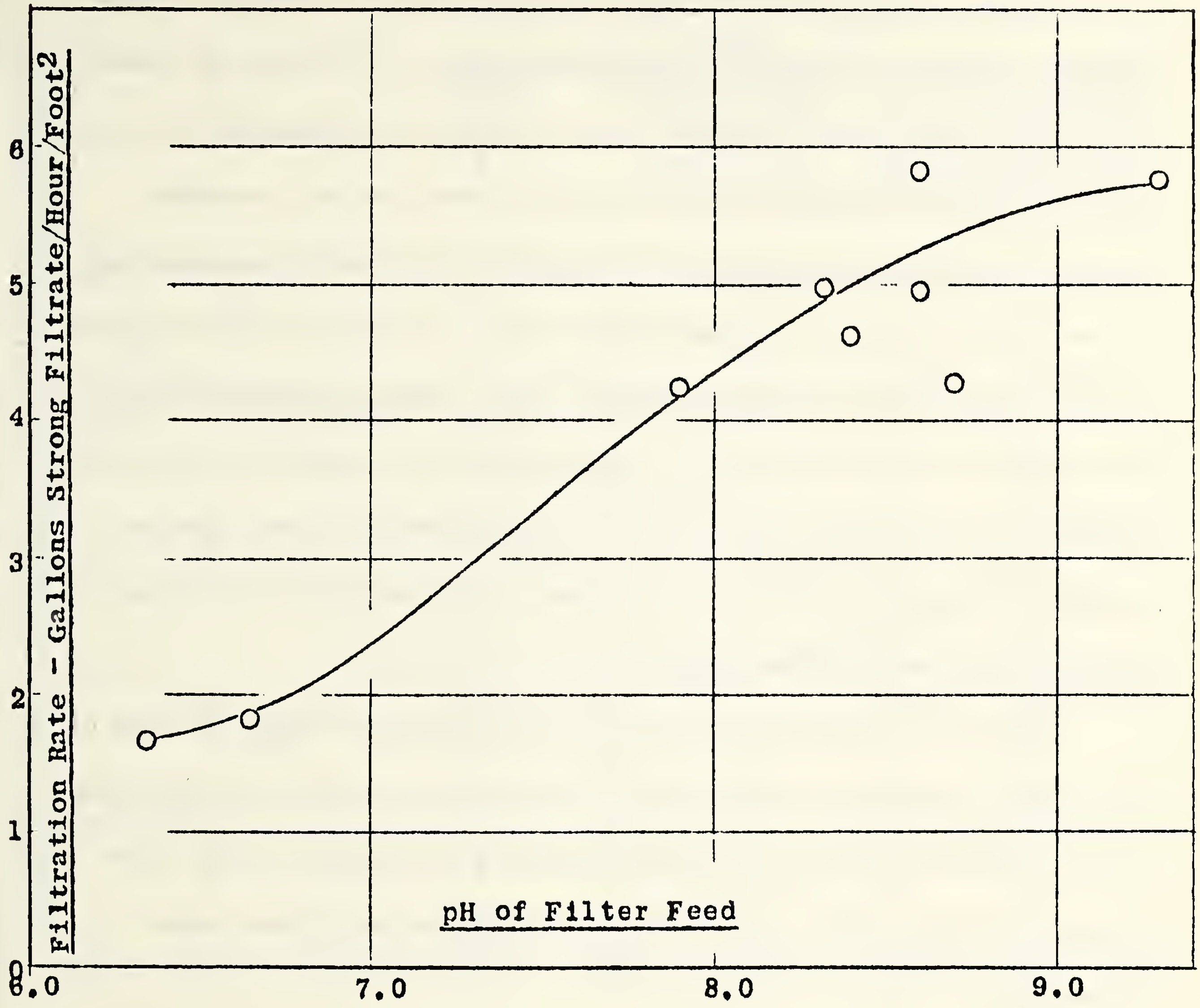

FIGURE 7

FILTRATION RATE AS A FUNCTION OF FEED pH

PILOT PLANT ROTOBELT FILTER AT A FLORIDA CANE SUGAR FACTORY

BASES: Filter Medium - Eimco Nylon 304
% Bagacillo On °Brix Of Mud - 11.8 to 16.3
Feed Temperature - 190 to 192°F
Feed Weight % Suspended Solids - 5.79 to 7.34
Mud °Brix - 16.4 to 18.8
Secondary Mud

Figure 8 is a plot of filtration rate as a function of bagacillo concentration. Two different ranges of feed pH for nylon and one range for cotton are given as parameters. All data is at a constant filter cycle time of three minutes per revolution. It will be first noted that rate increases slowly for all three parameters with an increase in bagacillo concentration. However, it is doubtful if excessive quantities of bagacillo can be justified merely for the slight increase in filtration rate. It is also apparent that in the case of the nylon medium, very large increases in bagacillo concentration at the low pH range of the unlimed mud from the secondary clarifier underflow would not yield rates equivalent to the low bagacillo concentrations with the same mud at a pH range of 7.9 to 8.3.

The cotton medium parameter of Figure 8 was at the same pH range of the higher rate parameter for nylon. In spite of this, bagacillo dosage had to be increased to achieve efficient filtration even though at about a 25% reduction in rate. This again points up the importance of filter media selection.

Filtrate purities ranged from 80 to 84%. Average for the plant juice is about 83%. Thus, either the filtrate could be sent directly to the evaporators or at worst be recycled back to the clarifier with only a negligible recirculating load of solids. This alone would materially assist the clarifier operation.

Primary mud was also filtered at the Florida factory with the pilot plant Rotobelt filter using the nylon medium. Filtration rates were very comparable and it is felt that both clarifier underflows can be dependably

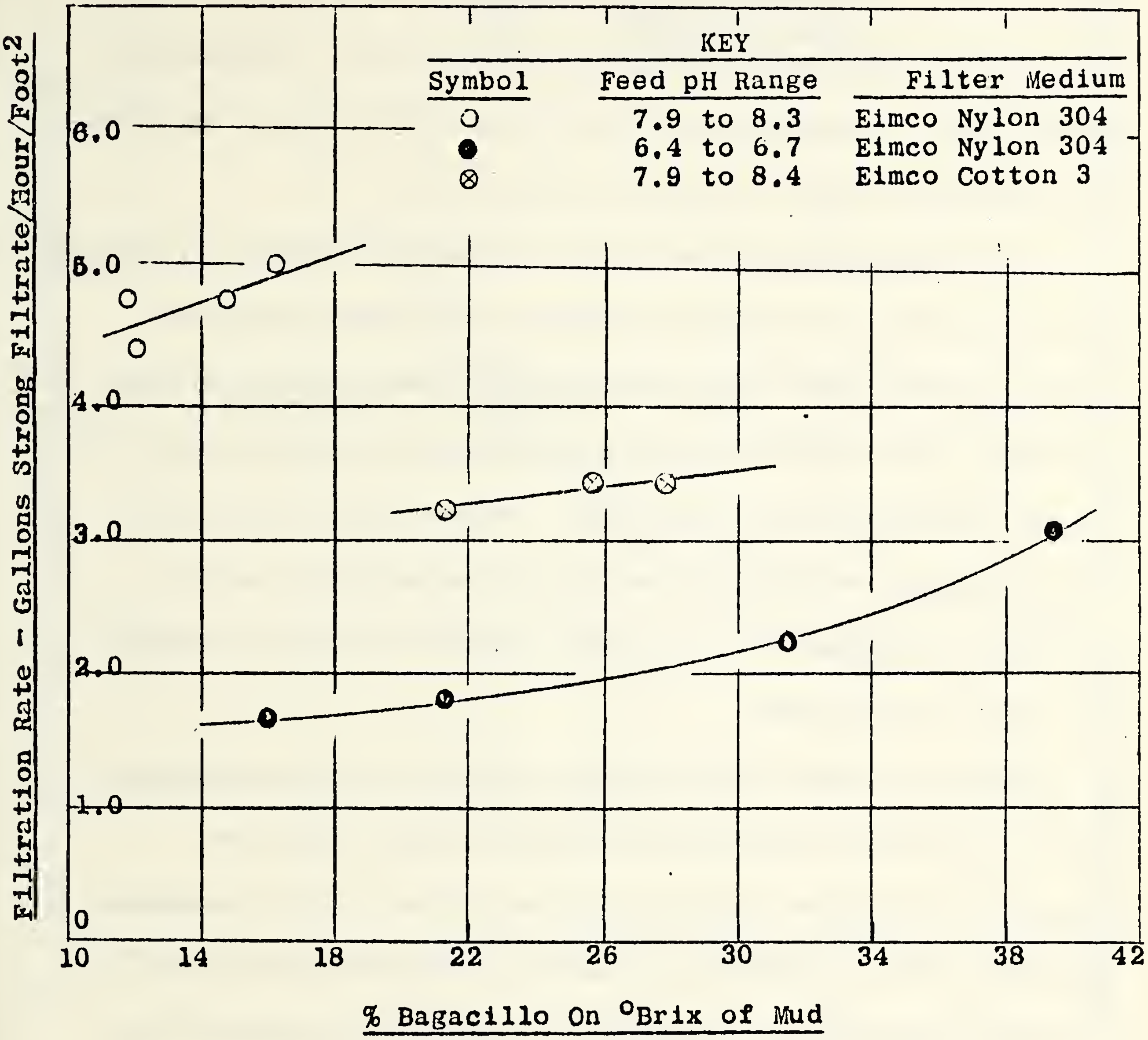

FIGURE 8

FILTRATION RATE AS A FUNCTION OF BAGACILLO CONCENTRATION

PARAMETERS OF FILTER MEDIUM AND pH RANGE

PILOT PLANT ROTOBELT FILTER AT A FLORIDA CANE SUGAR FACTORY

BASES: Feed Temperature = 174 to 190°F

Secondary Mud

filtered. This is further indicated by the fact that cakes as thin as 1/16 inch were discharged continuously by the Rotobelt filter. Furthermore the maximum cake thickness was never greater than 1/4 inch due to the phenomenon discussed earlier in connection with Figure 6.

In the pilot plant work performed at the Louisiana factory, an extended study was made under "bad mud" conditions. Many times during this period, the plant filters could not be operated effectively and had to be shut down. Thus, the performance of the Rotobelt Filter under severe operating conditions could be examined. The pilot plant setup was the same as employed at the Florida factory with the exceptions that no further lime was added to the secondary clarifier underflow and a different nylon cloth was used.

Figure 9 is a plot of filtration rate expressed as gallons of strong filtrate per hour per square foot as a function of filter cycle time. Bagacillo concentration and pH are constant. However, feed temperature varied from 181 to 195^{o}F which undoubtedly accounts for some of the scattering in the data. The bagacillo concentration was relatively high at 32.6% on ^{o}Brix of mud which of course was caused by the severe mud conditions. However, effective filtration resulted at all times at rates only a little below "good mud" rates.

Also included in Figure 7 is a parameter of filtrate clarity. This was measured by placing 10 cc's in a centrifuge tube and operating the centrifuge for two minutes. The volume percent of settled slude was then read directly from the graduated scale on the glass tube. As would be

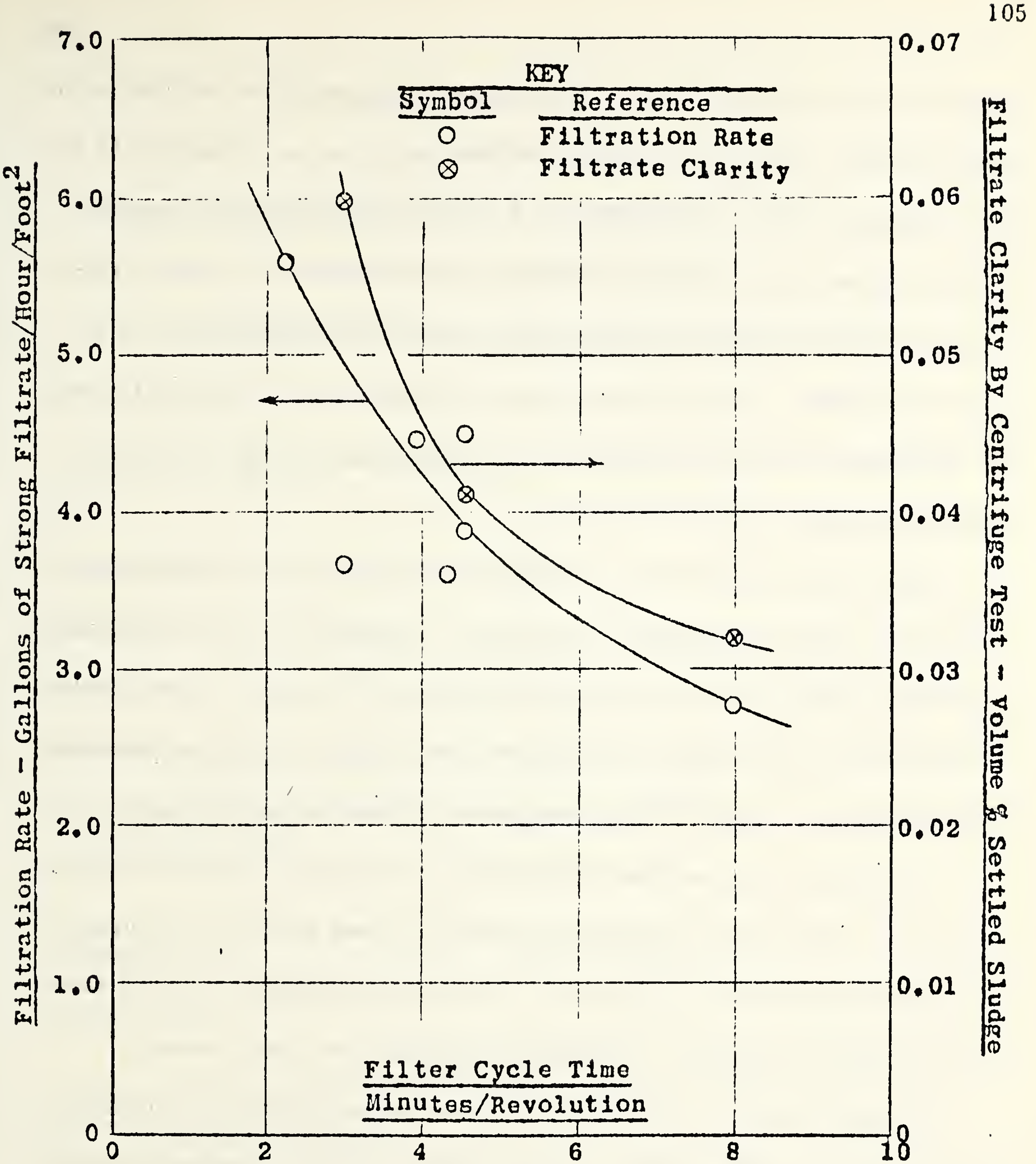

FIGURE 9

FILTRATION RATE AND FILTRATE CLARITY VS. FILTER CYCLE TIME

PILOT PLANT ROTOBELT FILTER OPERATING UNDER "BAD MUD" CONDITIONS

LOUISIANA CANE SUGAR FACTORY

BASES: 32.6% Bagacillo On Brix of Mud With 15.02 °Brix Mud,
8% Sucrose, 6.8 pH, 40 to 44 Vol.% Suspended Solids
Feed Temperature = 181 to 195°F
Eimco Nylon 384F Filter Medium

suspected, the volume percent of suspended solids decreases as filter cycle time increases. As the cake forms, the finer particles are "filtered out" by the deposited solids. Thus clarity, if necessary, can be further improved by using slower filter speeds. It should also be noted that the plant filters usually exhibited a filtrate contamination of 4 to 8 volume percent by the same test method. This obviously places a greater load on the clarifier and simultaneously longer retention times on the juice due to the necessity of recirculation back through the process.

Table I lists the composite average for the feed mud and filtrate over a day's run under the "bad mud" conditions. It would be noted that filtrate purity was 78.3%. Average purity for the plant is 77 to 78%. It was further stated by the factory that the filtrate was free enough from solids and clear enough to be sent directly to the evaporators with the clarified juice.

It will also be noted that the glucose ratio does not increase and the ash ratio is significantly decreased between the feed mud and the filtrate.* This means that there is no loss due to inversion of sugars and at the same time appreciable amounts of colloidal dispersoids are being removed.

Studies were also made on the influence of temperature on filtration results. This was done with a 0.1 square foot filter leaf operated to simulate the continuous vacuum filter cycle. The leaf test method was employed

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*The severe decrease in glucose ratio from feed to filtrate is probably not as great as indicated in the composite average of Table I. This is caused by averaging a number of glucose samples which were not necessarily taken at the same time as the samples for sucrose determination. However, no increase in glucose ratio was noted.

TABLE I

PILOT PLANT ROTOBELT COMPOSITE RESULTS

LOUISIANA CANE SUGAR FACTORY

OPERATING UNDER "BAD MUD" CONDITIONS

	Mud Feed	Filtrate
°Brix	15.02	10.97
Sucrose - %	8.00	8.59
Purity - %	53.26	78.30
Glucose - %	0.66	0.51
Glucose Ratio x 100	8.25	5.95
Clarity - Vol. % Settled Sludge by Centrifuge Test	40-44	0.061
pH	6.8	7.0
Ash (Sulphate) %	0.54	0.39
Ash Ratio x 100	6.75	4.54

NOTE: Operating Conditions -

Feed Temperature - 181 - 195°F

% Bagacillo on °Brix of Mud - 32.6

Filter Media - Eimco Nylon 384F

due to the impossibility of maintaining a constant temperature on the pilot plant Rotobelt Filter as explained earlier.

Figure 10 is a plot of filtrate clarity as a function of temperature in ^{o}F employing a nylon cloth. It will be noted that bagacillo concentration was 14.69% on ^{o}Brix of mud which is approximately average for "good mud" as tested on the pilot plant Rotobelt Filter. The cake formation time was maintained constant at one minute. As temperature increased, filtrate clarity improved decreasing from 0.079 volume percent sludge at 140^{o}F to only 0.42% at 200^{o}F. Thus, higher operating temperatures should result in better clarity of filtrate.

Figure 11 is a plot of filtration rate as a function of feed temperature for the leaf tests. Again, and as would be suspected, filtration rate improves with temperature exhibiting a very large percentage increase from 140^{o} to 200^{o}F.

FULL SCALE ROTOBELT FILTER APPLICATIONS

The Rotobelt Filter has been applied in several different industries such as sewage sludges of all types, paper mill wastes, grits and fiber dewatering in corn processing, etc. Several of these applications previously have not been possible on a continuous basis due to rapid blinding, or difficult cake formation that could not be discharged from the conventional drum filter. However, because of the similar nature of the industry, a recent installation in a beet sugar factory will be discussed in detail.

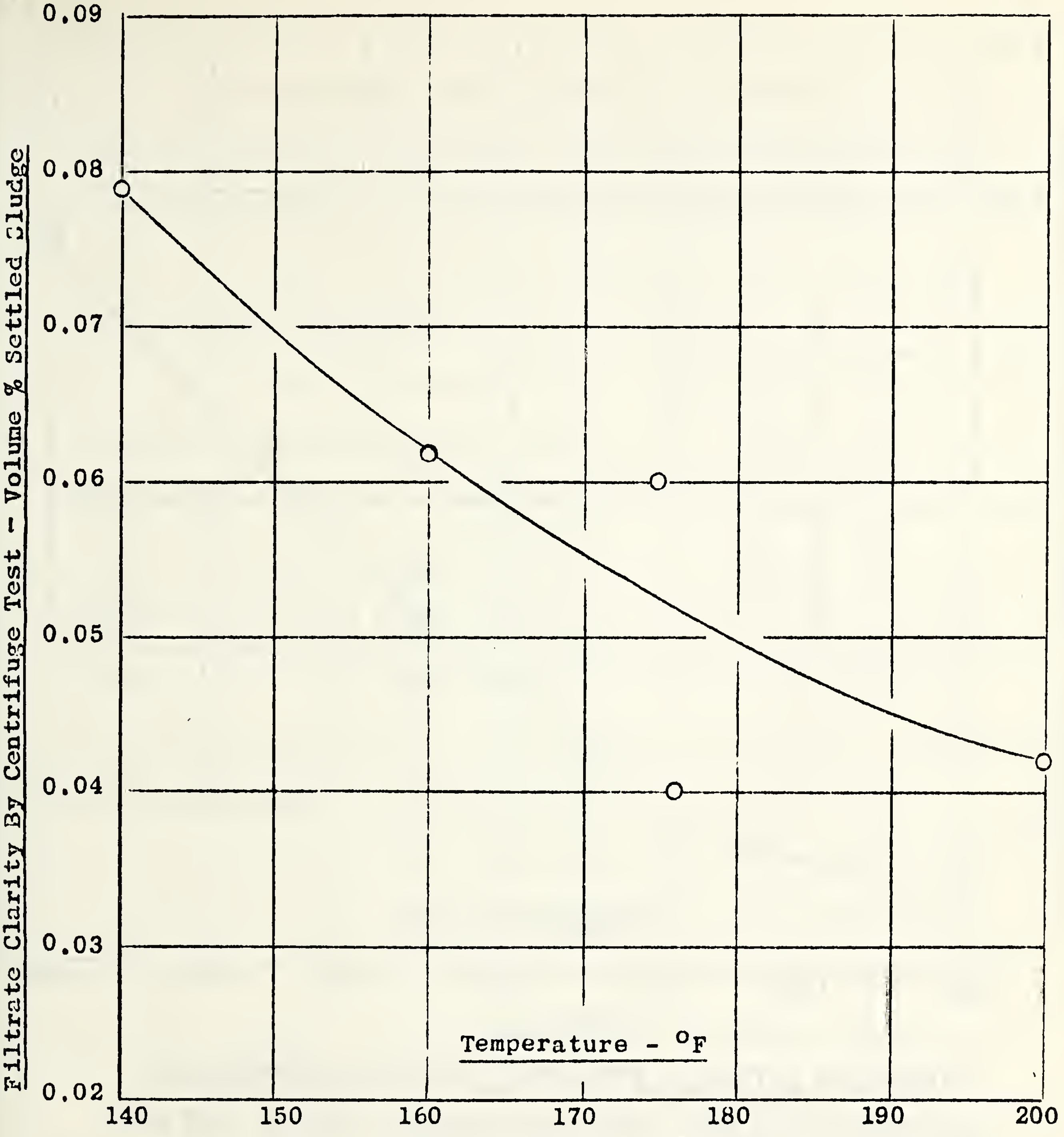


FIGURE 10

FILTRATE CLARITY AS A FUNCTION OF MUD FEED TEMPERATURE

0.1 SQUARE FOOT LEAF TESTS ON LOUISIANA FACTORY CANE MUD

BASES: 17 to 17.6° Brix Mud, pH of Mud 7.0 to 7.3, 46 Vol.% Suspended Solids in Mud
14.69% Bagacillo on °Brix of Mud
Eimco Nylon 319F Filter Medium
1.0 Minute Cake Formation Time

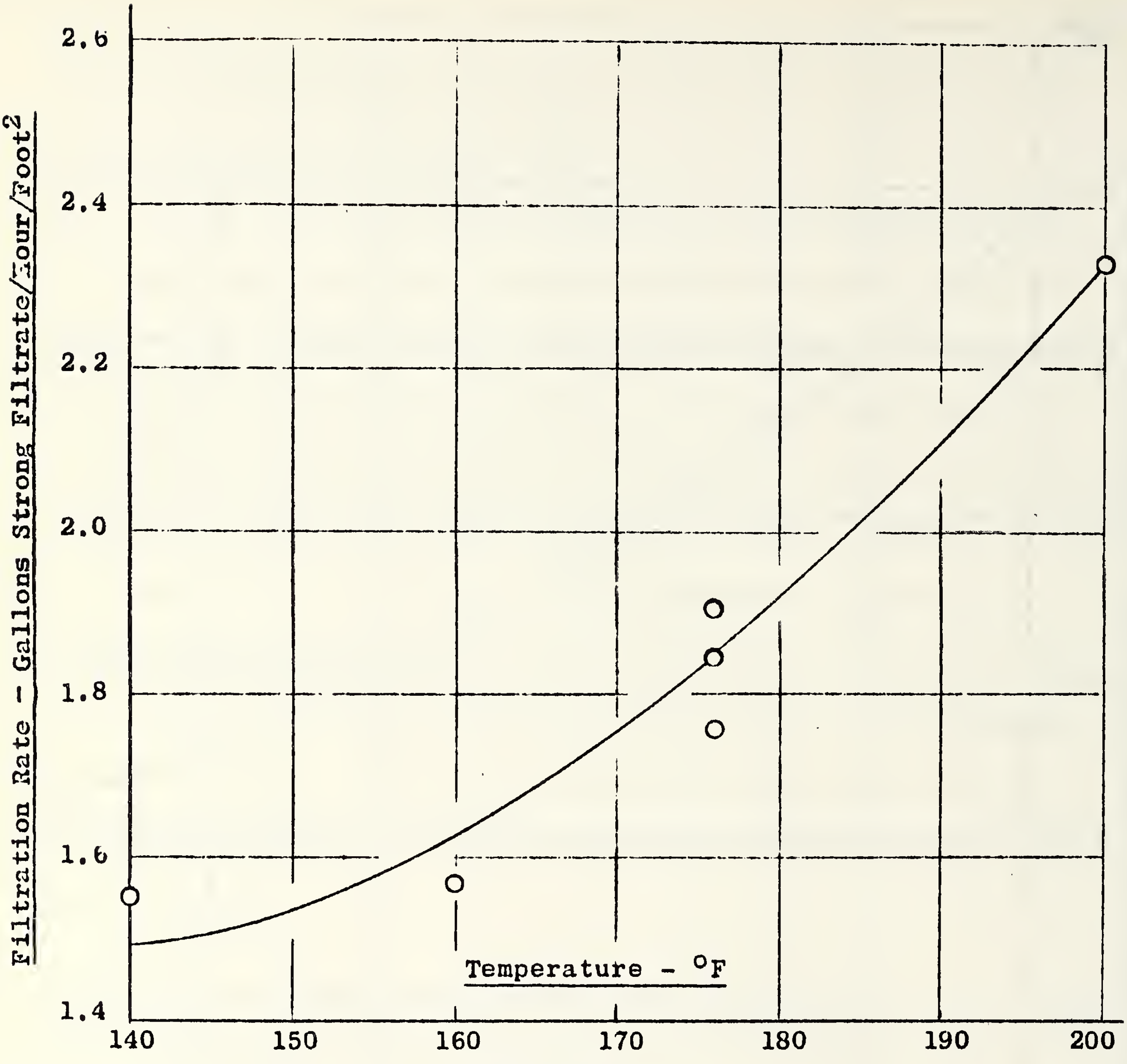


FIGURE 11

FILTRATION RATE AS A FUNCTION OF FEED MUD TEMPERATURE

0.1 SQUARE FOOT LEAF TESTS ON LOUISIANA FACTORY CANE MUD

BASES: 17 to 17.6° Brix Mud, pH of Mud 7.0 to 7.3, 46 Vol.% Suspended Solids in Mud

14.69% Bagacillo on ° Brix of Mud

Eimco Nylon 319F Filter Medium

1.0 Minute Cake Formation Time

30% Effective Filter Submergence

An 8' diameter by 14' face Rotobelt Filter was applied to the direct filtration of first carbonation juice. A picture showing a portion of the installation is given in Figure 3. The filter is receiving the same feed as a clarifier installed in parallel with it. Operating results for the month of January 1959 will be given.

Figure 12 is a chronological plot of average filtration rate expressed as gallons of strong filtrate per minute per foot^2. Filtration rates, except for a period of four days, ranged from 0.62 to 0.76 gallons per minute per foot^2. During the four day period, average rates dropped to 0.48 to 0.57 gallons per minute per foot^2. Inspection of the cloth washing spray indicated that some of the sprays had become plugged and the medium was not being completely washed. When the sprays were cleaned, performance returned to normal.

The partial loss of rate is significant as it illustrates the necessity of maintaining a clean medium on this application. It is understood that earlier attempts to perform this type of filtration with conventional cloth covered drum filters had been made. Probably the failure was due to the impossibility of maintaining a clean medium on these types of units.

Average clarity of filtrate is compared with the clarifier overflow in Figure 13. The clarity is determined by the centrifuge method as described earlier. It will be noted that in every case but one, clarity was equal to or less than 0.1 volume % sludge. In addition, the centrifuge tubes employed in the determination have a minimum observable reading of 0.05 volume %. Thus, clarities exceeding this are reported by the

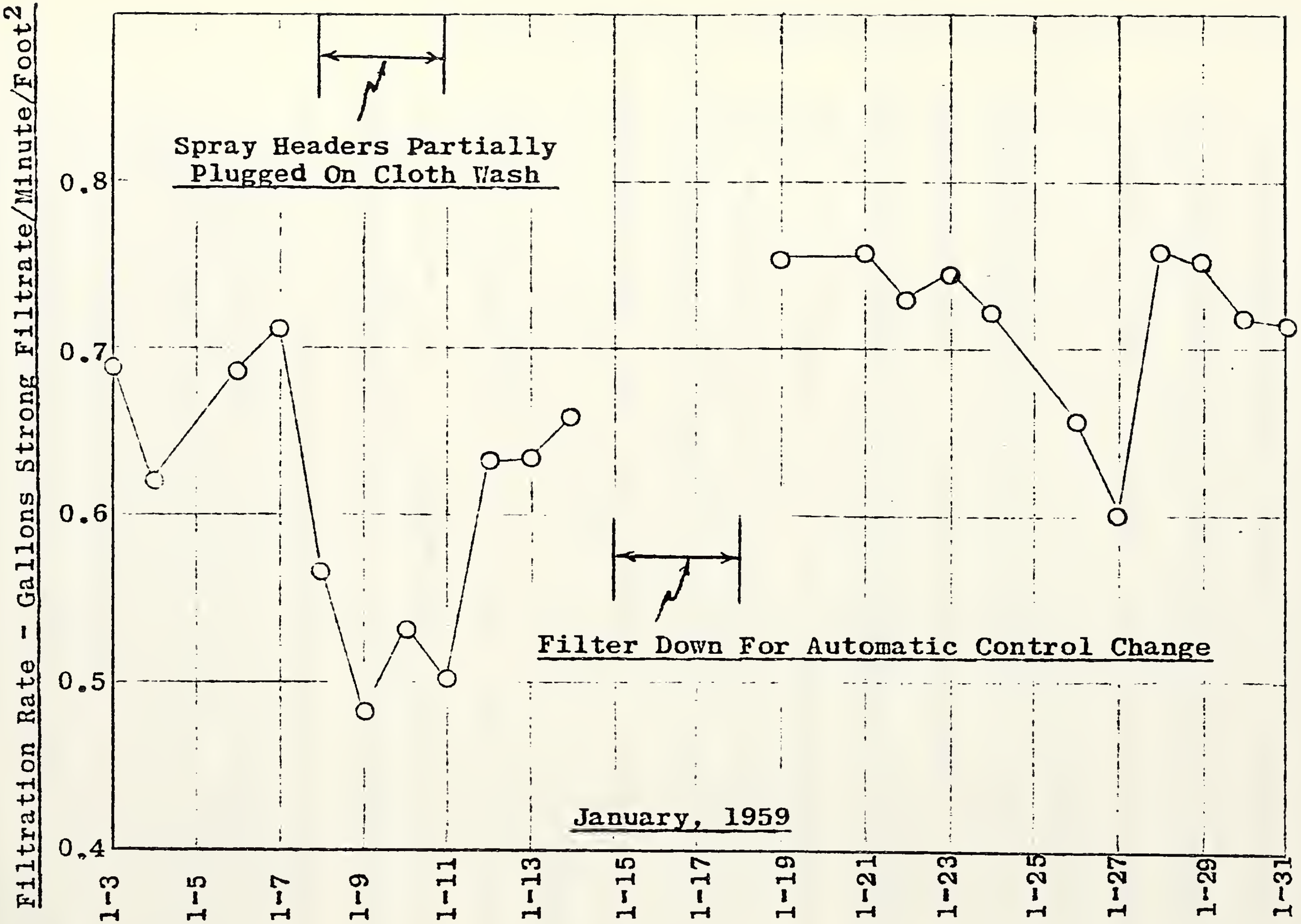


FIGURE 12

AVERAGE FILTRATION RATE DURING JANUARY, 1959

8'D x 14' FACE EIMCO ROTOBELT FILTER ON DIRECT FILTRATION OF FIRST CARBONATION JUICE

BEET SUGAR FACTORY

BASES: Filter Cycle Time - 2 Minutes/Revolution
40% Submergence
Feed Temperature - 140°F

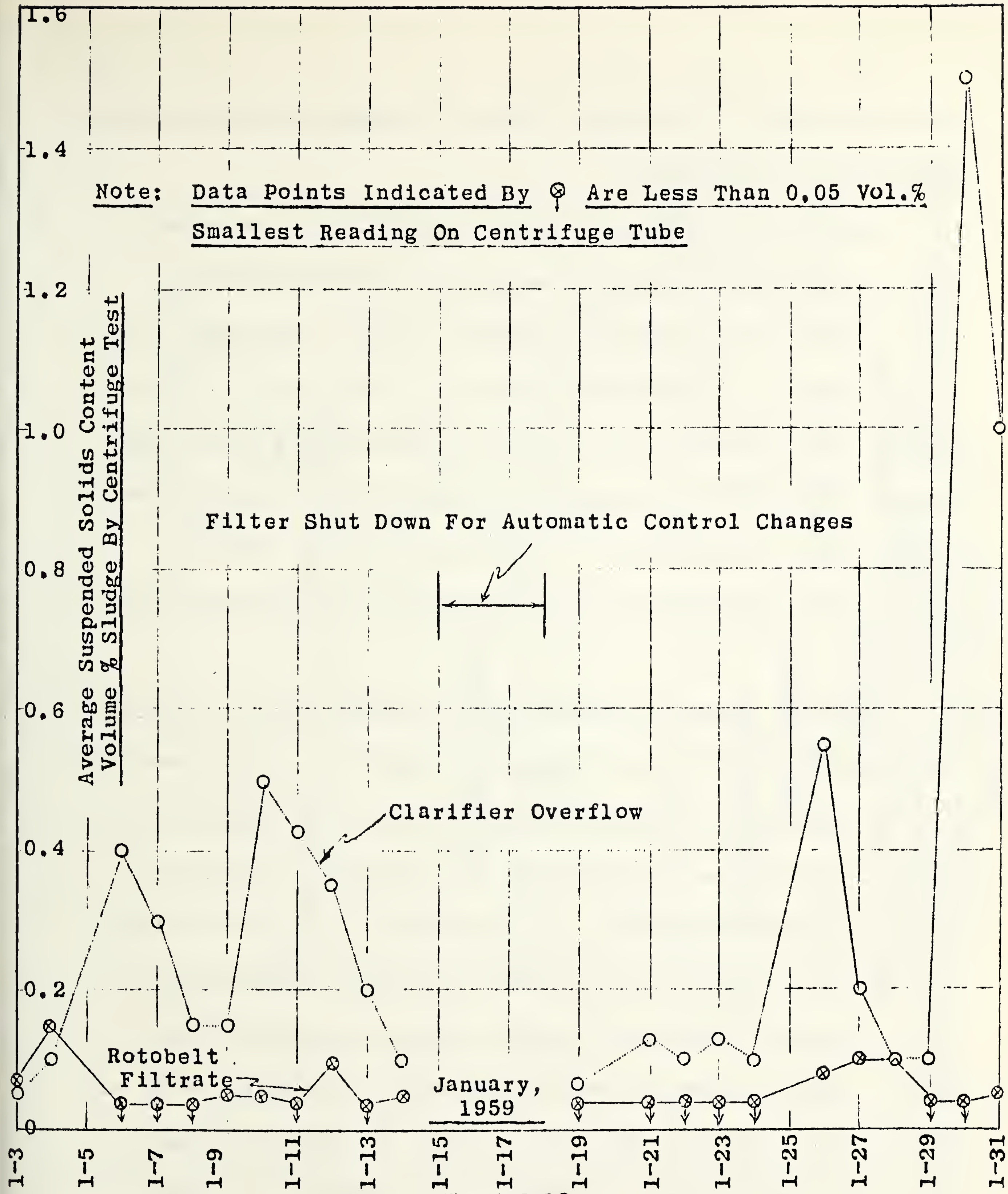


FIGURE 13

COMPARISON OF SUSPENDED SOLIDS IN ROTOBELT FILTRATE

AND CLARIFIER OVERFLOW DURING JANUARY, 1959

8'D x 14' FACE EIMCO ROTOBELT ON

DIRECT FILTRATION OF FIRST CARBONATION JUICE

CLARIFIER ON FIRST CARBONATION JUICE

BEET SUGAR FACTORY

plant as less than 0.05 volume %. Twelve of the twenty-two daily averages reported are in this category.

Also indicated on Figure 13 is the average clarity for the clarifier overflow. Except for three days, one of which clarities were equal, filtrate clarity exceeds that of the clarifier overflow. Furthermore, it is apparent that the Rotobelt Filter will absorb "shock loadings" to a greater degree. Very severe swings in clarity are evident with the clarifier and a return to desirable operating levels generally requires a longer period of time. This is largely due to the much longer retention time in the thickener with a resultant severe lag in time after corrections have been applied.

Alkalinity change between the first carbonation feed and the filtrate or overflow on the two units is compared in Figure 14. It will be noted that lower alkalinity changes are always experienced on Rotobelt Filters. Also plotted on Figure 14 is the difference in alkalinity change between the clarifier and Rotobelt Filter. Average alkalinity difference over the month was 0.01 in favor of the Rotobelt Filter with an improvement to an average of 0.012 in the last 13 days after certain modifications had been made. As this is a measure, to a certain extent, of the quality of the thin juice produced, i.e., the higher the alkalinity the better is the quality of the thin juice produced as judged by color, lime salts, and colloidal content, operation at low alkalinity change is desirable.

Figure 15 is a similar plot for average effective alkalinity and again shows the improvement achieved by the Rotobelt Filter. The average

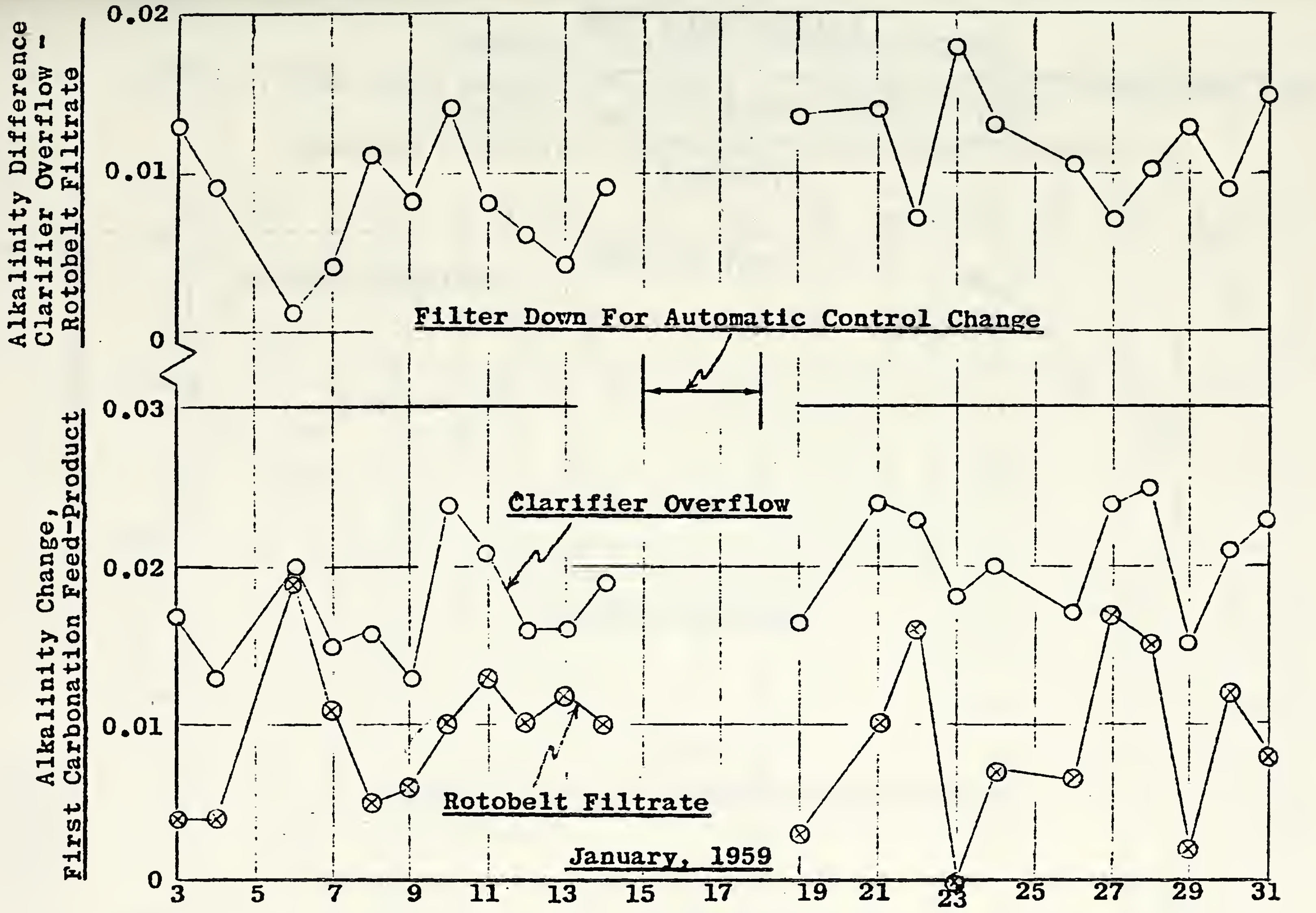


FIGURE 14

ALKALINITY COMPARISON FOR ROTOBELT FILTRATE AND CLARIFIER OVERFLOW DURING JANUARY, 1959

8'D x 14' FACE EIMCO ROTOBELT ON DIRECT FILTRATION OF FIRST CARBONATION JUICE

CLARIFIER ON FIRST CARBONATION JUICE

BEET SUGAR FACTORY

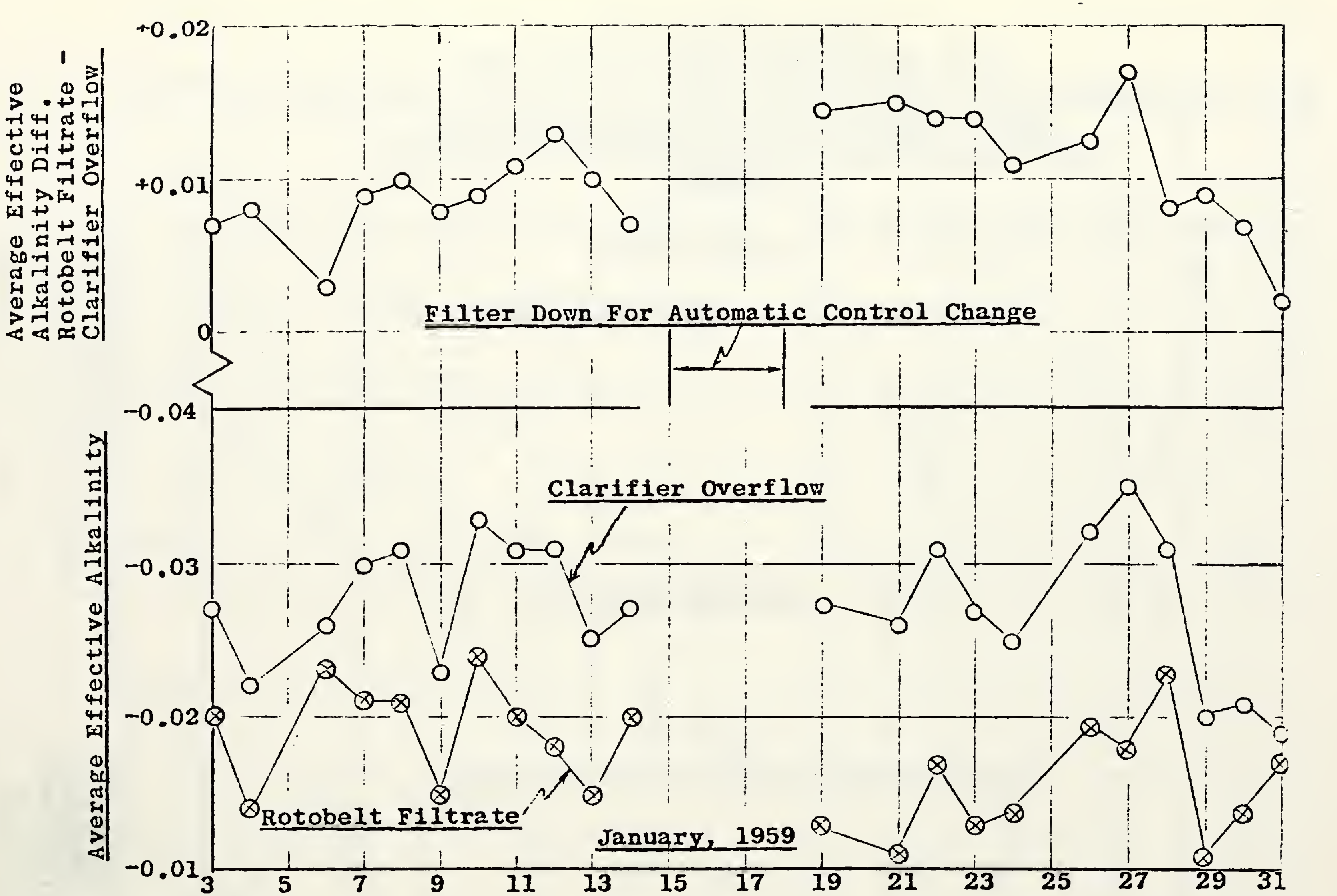


FIGURE 15

EFFECTIVE ALKALINITY COMPARISON FOR ROTOBELT FILTRATE AND CLARIFIER OVERFLOW DURING JANUARY, 1959

8'D x 14' FACE EIMCO ROTOBELT ON DIRECT FILTRATION OF FIRST CARBONATION JUICE

CLARIFIER ON FIRST CARBONATION JUICE
BEET SUGAR FACTORY

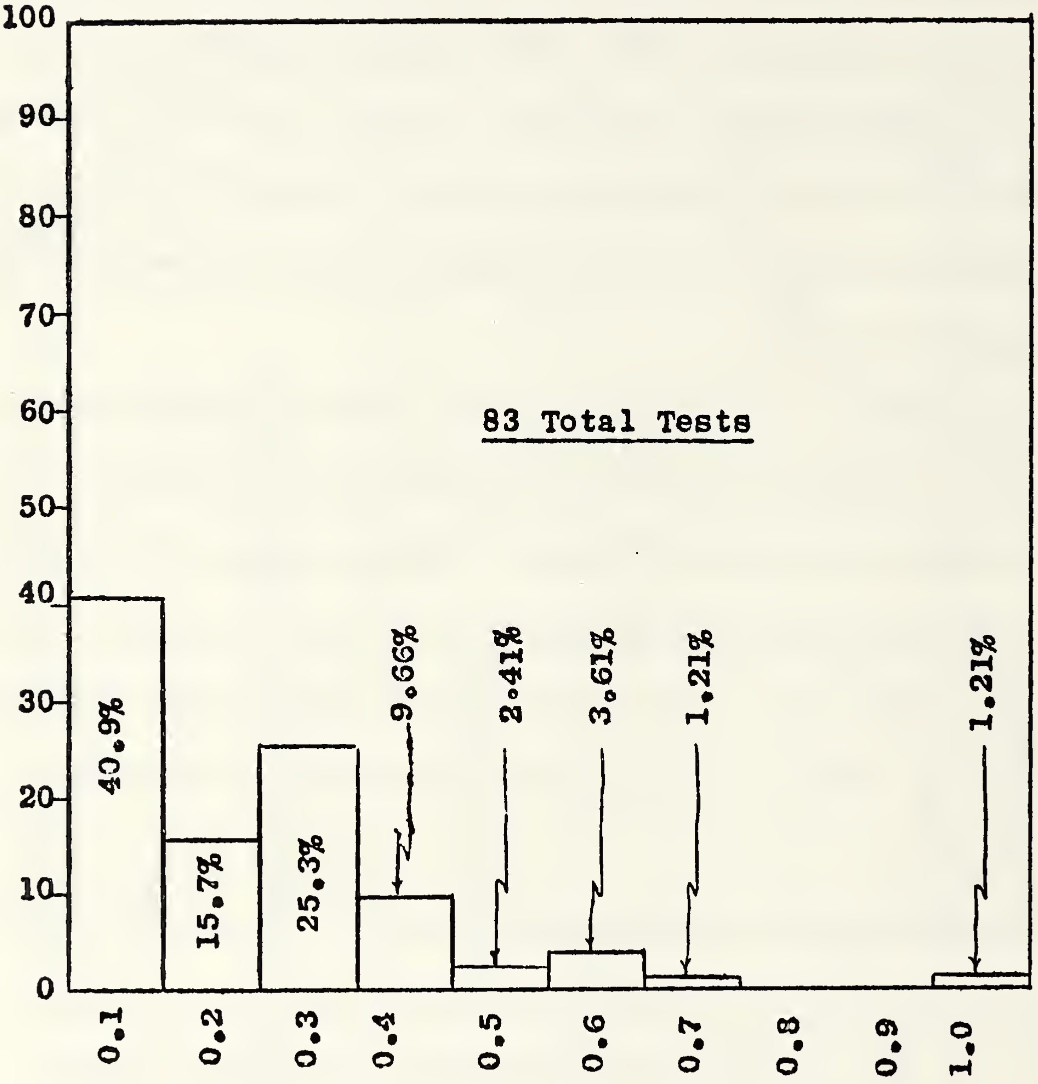
effective alkalinity difference between the two units for the month was 0.01 in favor of the Rotobelt Filter. This is partly a measure of sucrose inversion and would indicate the possible economic savings in this regard. It should also be noted that effective alkalinity is indicative of chemical requirements (Soda ash) in second carbonation and thus additional economy is possible by filtration.

Sucrose content of the discharged filter cake is plotted by a statistical distribution graph in Figure 16. Sucrose content is determined on the basis of weight % of wet cake before it is sluiced to waste. It will be noted that the median would lie at approximately 0.207 Wt.% for the 83 analyses performed. Furthermore, only 8.44% of the tests exhibited values greater than 0.4 Wt.%. Thus, a very high sucrose removal from the wet cake is possible.

The results of the installation to date indicate the excellent clarities that can be achieved on the Rotobelt Filter which appear to appreciably exceed those of a clarifier. Sucrose inversion is appreciably reduced as are chemical requirements in second carbonation. Additionally the Rotobelt Filter possesses greater flexibility and the ability to adjust to or absorb shock loadings which is lacking in the clarifier due to the long retention times.

SUMMARY

The Rotobelt Filter has been developed to take advantage of optimum continuous filtration. By use of an endless belt filter medium that is removed from the drum continuously, a clean filter surface is continually



Weight Percent Sucrose In Wet Filter Cake

FIGURE 16

SUCROSE IN DISCHARGED FILTER CAKE FROM ROTOBELT FILTER

8'D x 14' FACE EIMCO ROTOBELT ON

DIRECT FILTRATION OF FIRST CARBONATION JUICE

BEET SUGAR FACTORY

available because of the spray wash on both sides of the cloth. In addition, the sharp change in the radii of curvature for the cake and medium as they pass over the small diameter discharge roller substantially assist in cake discharge. Thus, much thinner filter cakes can be handled permitting faster filter cycles and higher productive capacities. Because of the isolation of the individual drum sections by the sealing method, no leakage between the atmosphere or the feed slurry under the filter media is possible. The unit therefore possesses all the flexibility of the conventional continuous drum filter. In addition, down time for changing of filter media is negligible due to the zipper closure on the endless belt.

The application of the Rotobelt Filter to cane mud filtration has been tested on a pilot plant basis in two different factories in Louisiana and Florida. Results in both cases were very encouraging and lead to the following advantages for improvement in cane mud filtration.

1. Probability of being able to pass on the Rotobelt filtrate directly to evaporation because of its excellent clarity and purity. This will also yield economic savings in the reduction of sucrose inversion. The clarity of filtrate obtained in the pilot plant work was considered of sufficient clarity to go directly to evaporation at the plants tested. Even if recirculation of the filtrate became necessary, the reduction of circulating mud load to a negligible value would result in an improved performance of the clarifier.

2. Relatively stable performance under all types of mud conditions. Presently, "bad mud" conditions result in difficult or impossible filter operations and further upset clarifier results.

3. Reduction in lime requirements and bagacillo dosages.

4. Improved sucrose removal from the filter cake by more effective cake washing due to the thinner cakes that are handled together with the clean media.

5. Significant decrease in ash content and no change in the glucose ratio of the juice.

6. Reduced equipment maintenance by reduction of abrasion caused by the solids presently carried in the conventional cane mud filtrate.

7. Primary as well as secondary clarifier underflow can be filtered on the Rotobelt Filter. Thus, further reduction in retention time with decreased sucrose loss is possible.

8. Increased grinding rate of the mills by elimination of severe process upsets due to recirculating mud loads. This would also improve process control.

The Rotobelt Filter has already experienced a large number of installations in several industries. Many of the applications are on problems that previously could not be handled by conventional continuous filtration equipment. One application on direct filtration of first carbonation juice in a beet sugar plant has been examined in detail based on plant operating results during the month of January, 1959. As the objectives are essentially the same as with cane mud filtration, the superior performance of the Rotobelt Filter over the clarifier is of great importance. The advantages cited above are readily apparent, in this installation. It should also be noted that to the authors' knowledge, this operation on a continuous basis has never been successfully achieved in previous attempts. No attempt has been made to filter raw cane juice directly but because of the success in beet sugar, undoubtedly this also should be tried.

ECONOMIC VALUE OF MECHANICAL CIRCULATION IN VACUUM PANS

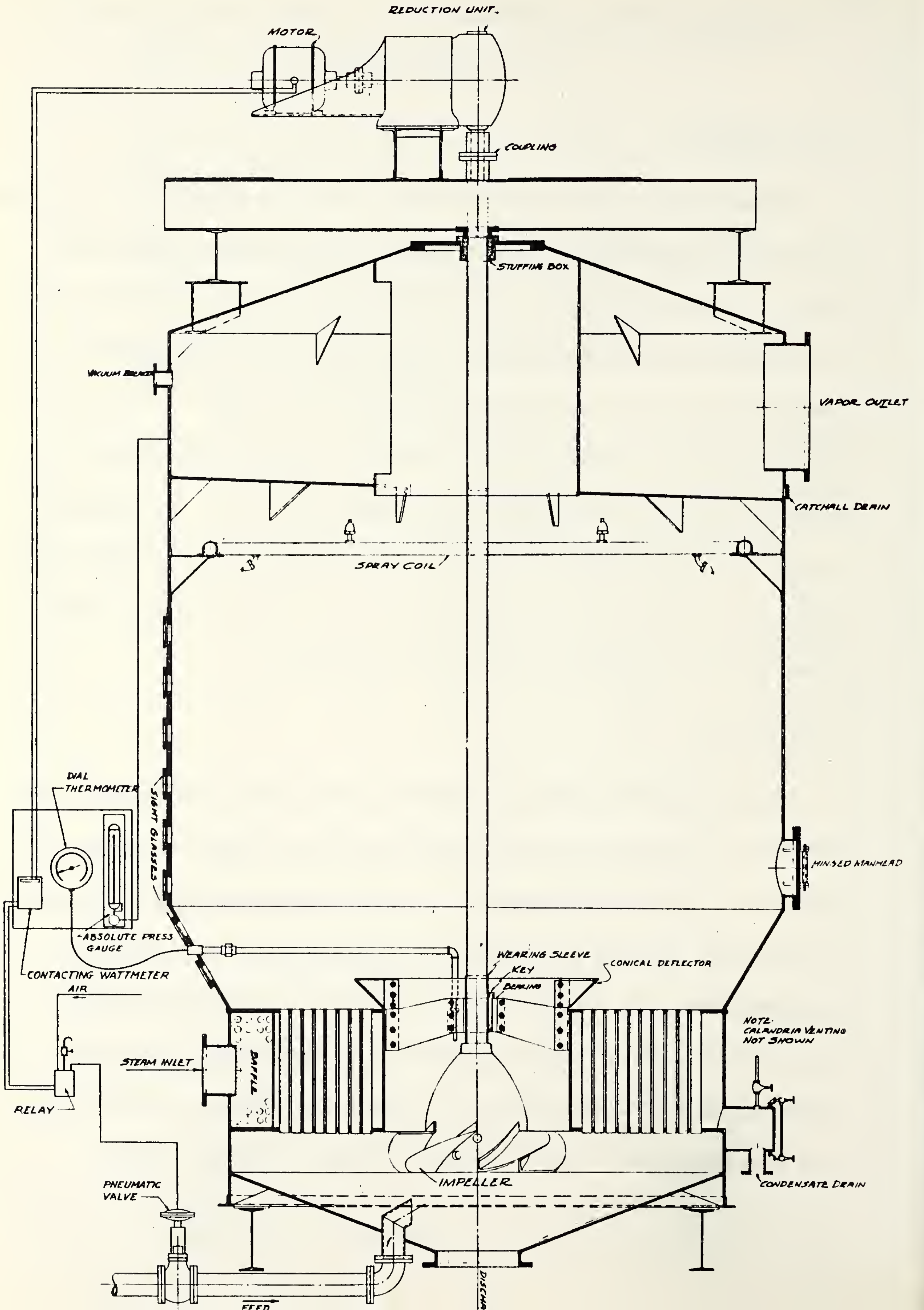
W. T. Abercrombie, Jr.

INTRODUCTION

Improvements in the quality of sugar and in the exhaustion of molasses are of major interest to the Sugar Industry. A considerable step in this direction is achieved by the use of Mechanical Circulation in Vacuum Pans, as has been established in over 200 installations in Cane Sugar Factories, Beet Sugar Factories, and Refineries throughout the world. As a very attractive additional advantage, there results a significant increase in the capacity of the pans, especially in low grade work, where it is doubled. Credit for the rehabilitation of Mechanical Circulation and its outstanding performance is due to the untiring efforts of Mr. Alfred L. Webre, well known Sugar Technologist and a native of Louisiana.

DESCRIPTION

The Circulator consists of a screw pump impeller located below the downtake, supported on a sturdy steel shaft with a center bearing in the downtake just above the impeller. This shaft extends above and through the top of the pan with a stuffing box and driven through a solid flange coupling fastened to the low-speed shaft of the speed reducer, which is equipped with adequate thrust bearings. An electric motor drives the reducer through a flexible coupling. The motor and reducer unit are mounted on a structural steel support fastened to the top of the Vacuum Pan.

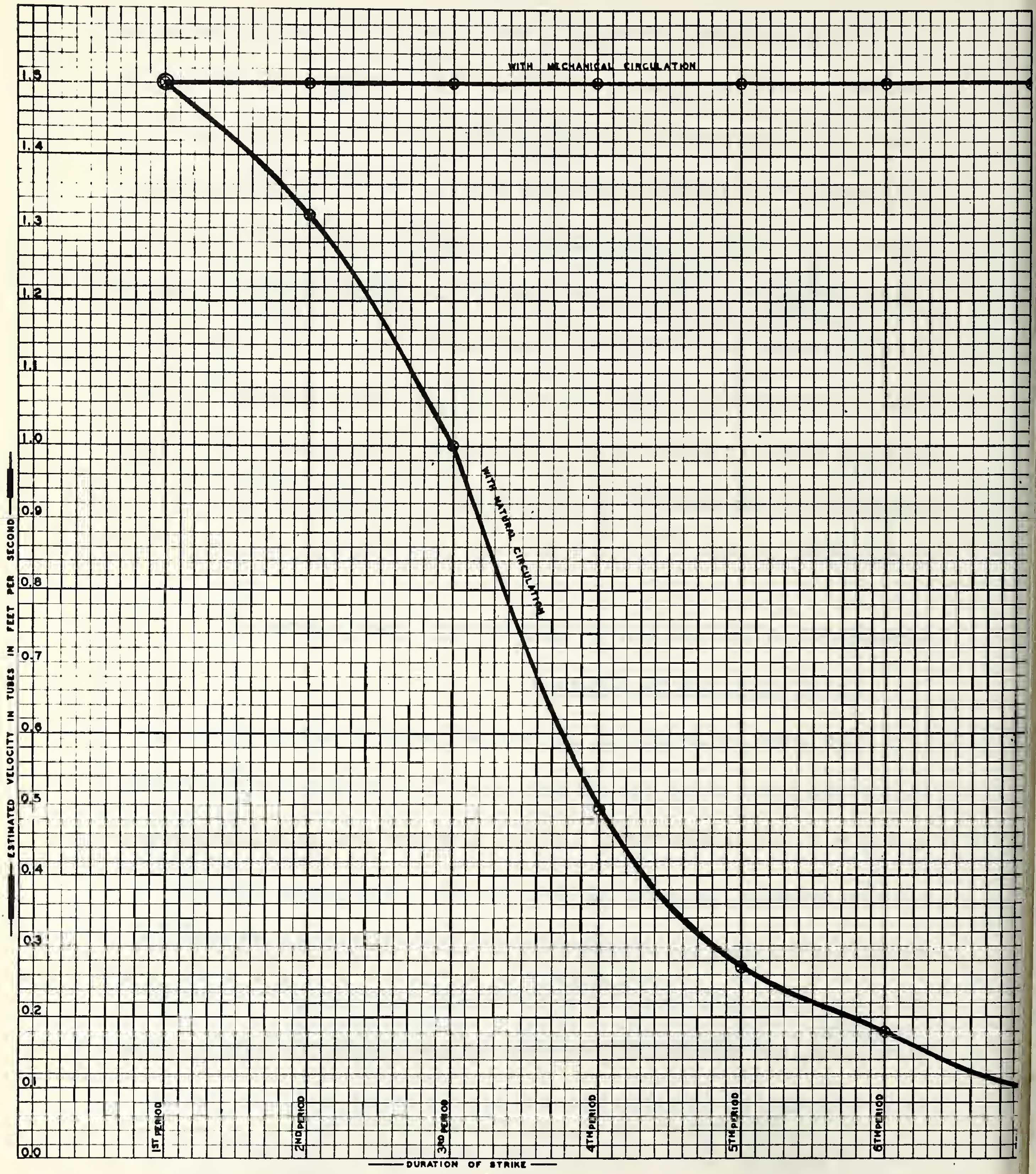

REDUCTION UNIT.
MOTOR
COUPLING
STUFFING BOX
VACUUM BREAKER
VAPOR OUTLET
CATCHALL DRAIN
SPRAY COIL
DIAL THERMOMETER
SIGHT GLASSES
HINGED MANHEAD
ABSOLUTE PRESS GAUGE
CONTACTING WATTMETER
AIR
WEARING SLEEVE
CONICAL DEFLECTOR
KEY
BEARING
NOTE: CALANDRIA VENTING NOT SHOWN
STEAM INLET
BAFFLE
RELAY
PNEUMATIC VALVE
IMPELLER
CONDENSATE DRAIN
FEED
DISCHA

The pump element consists of six (6) cast bronze special screw vanes attached to a hollow streamlined impeller drum. The top part of the drum is fitted to the lower end of the tapered shaft, keyed and bolted. At the cylindrical part of the hub under each vane are two (2) 2" holes. Feed enters the pan through one opening in the bottom and is directed into the hollow portion of the drum of the impeller. By centrifugal force, it is made to pass through these holes under each rapidly moving vane. This movement causes immediate mixture between the circulating massecuite and incoming feed. To eliminate short circuiting of the massecuite, in the tubes close to the periphery of the downtake, a conical deflector is provided.

ADVANTAGES WITH THE USE OF MECHANICAL CIRCULATORS

Low Fluidity and Its Effects:

The urgent necessity for mechanical means of moving massecuite through the tubes of the vacuum pan comes from the fact that due to the viscosity of the Mother Liquor, and the presence of a large percentage of sugar crystals, the mass has lost fluidity. This means that the natural force producing circulation by the formation of vapor bubbles in the tubes is not sufficient to cause adequate movement. This partial stagnation, not only reduces the rate of evaporation, but, what is worse, allows the film of the exhausted molasses to remain in longer contact with the sugar crystals, thus definitely retarding their growth and visiating the entire operation.



ESTIMATED SPEED OF CIRCULATION
IN TUBES OF VACUUM PAN WITH
"C" STRIKE

SPEED OF CIRCULATION

In a calandria vacuum pan with natural circulation, as the height of the massecuite above the heating surface increases, it is certain that the reduction of velocity in the tubes is at least as great as the reduction of the rate of evaporation. On this assumption, the estimated speeds in the tubes were calculated for a "C" strike operating normally, and whose performance was carefully logged. This is shown in our attached curve.

FEED DISTRIBUTION

We have already mentioned the way in which feed enters the pan with mechanical circulation. Normally made charges or drinks tend to rise and float on top of the boiling mass, which takes a long time to mix in and sometimes do not mix in at all. Mechanical circulation corrects this condition by speeding up the movement of the viscous mass and increasing the rate of evaporation.

AUTOMATIC FEED

Many mechanical circulators are provided with a well-proven automatic feed. Since the power developed by the motor is proportional to the "tightness" of the strike, then by controlling the load on the motor, the tightness of the strike is automatically maintained.

Operators are prone to carry the strikes too loose. Little is gained and much is lost by this practice. The virtue of the automatic feed is that it corrects this condition and controls the feed at a rate to maintain maximum crystal growth and exhaustion of the sucrose of the Mother Liquor.

Vacuum pans work better and faster if held tight and danger of forming conglomeration and false grain is eliminated.

VACUUM PAN CONTROL INSTRUMENTS

In order to obtain satisfactory formation and growth of sugar crystals, the use of the saturation control instruments is recommended. By so doing, the quality of work can be improved, and since the important variables are plainly indicated, there will result a remarkable uniformity of product. Once the footing is tightened, the automatic feed is placed into operation and allowed to control until the full level of strike is reached.

SPEED OF OPERATION

The time required for completion of a strike has been materially reduced under the same operating conditions and actual records indicate the following changes:

"A" Strike requires 85% natural circulation time

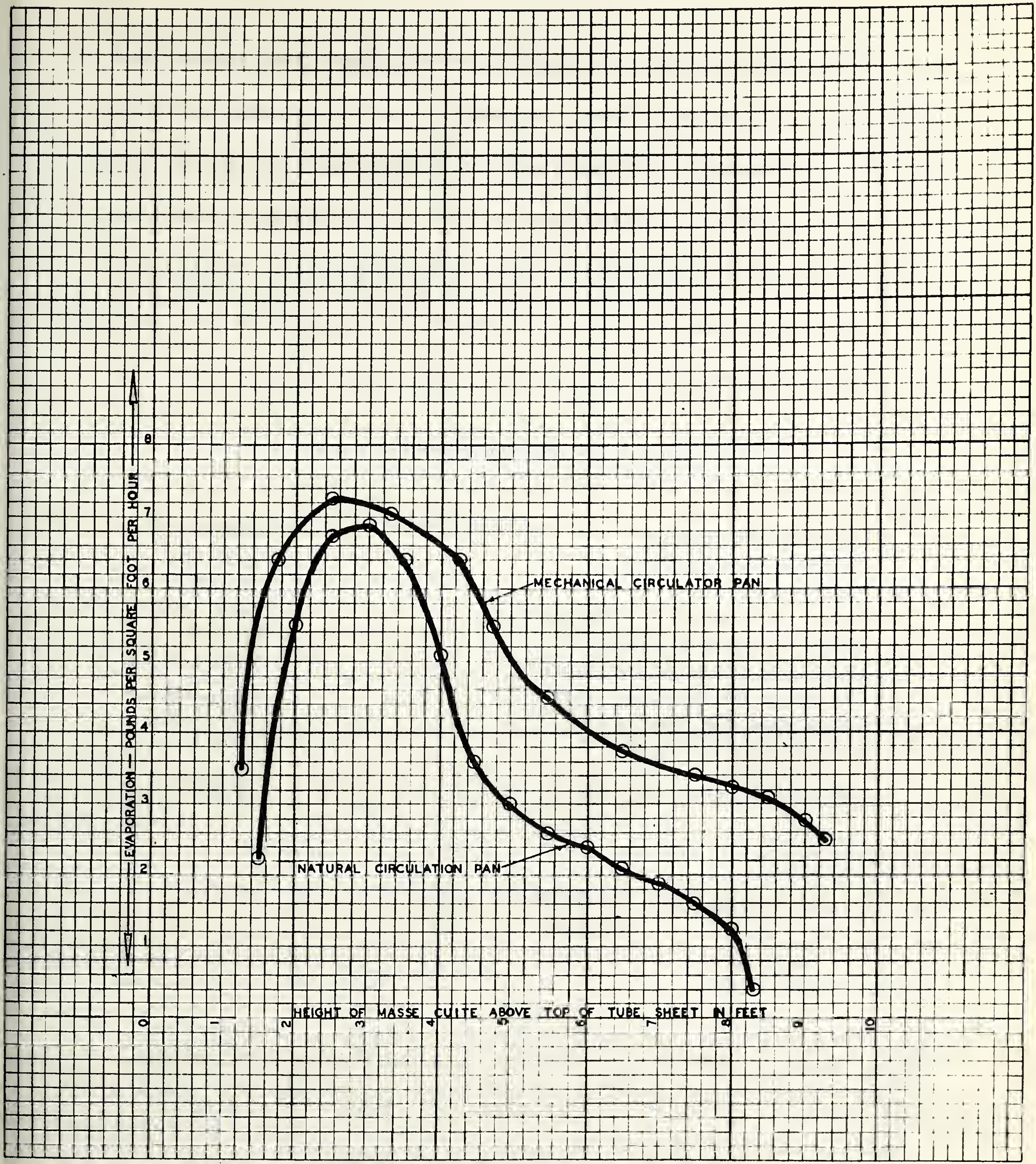
"B" Strike requires 75% natural circulation time

"C" Strike requires 50% natural circulation time

With mechanical circulation, higher strikes can be made without undue loss of time and satisfactory performances are obtainable with lower steam pressures.

INCREASED CAPACITY OF PANS

For calculations in this paper, 10'-0" diameter straight side calandria pans are used with 4" O.D. tubes 4'-0" long, having a footing of 321 cu. ft.



COMPARATIVE PERFORMANCE
OF DUPLICATE 12'-0" PANS
WITH & WITHOUT
MECHANICAL CIRCULATION

With natural circulation 5'-6" above the top tube Sheet, the capacity will be 750 cu. ft., whereas, with a mechanical circulator installed in the same pan, it would have an 8'-0" high strike and a capacity of 950 cu. ft. This equals 200 cu. ft. or 26.7% increase in capacity. With a High Speed Pan, additional contents are available without increasing the hydrostatic head of the massecuite. (A 10'-0" x 12'-6" pan has 1250 cu. ft. at 8'-0" or 25% increase capacity.)

TYPICAL LOUISIANA CASE PAN WORK

Grinding rate per day	2000 Tons
Grinding rate per hour	166,666 Lbs
Yield assumed at	9.0 %
Sugar produced (166,666# x 9%) =	15,000 Lb/Hr.
Purity of syrup or meladura	80.0 %
"A" Sugar produced per chart =	5011 Lbs.
"B" Sugar produced per chart =	2456 Lbs.
Total Sugar Per Hour =	7467 Lbs.
Actual sugar per hour =	15,000 Lbs.
Chart factor = $\frac{15,000}{7467}$ or	2.01

Meladura solids to pans per hour = 10,000# x 2.01 = 20,100#

Brix of juice to Evaporator $\frac{20,100\#}{166,666}$ = 12.1 Bx

Cubic Feet of Strike

Kind	Cu. Ft. Chart	Factor	Example Cu. Ft. Per Hr.	Example Cu. Ft. Per Day	750 Cu. Ft. Strikes/Day 10'-0" pans
"A"	103 x	2.01 =	207.0x24=	4980	6.65
"B"	58 x	2.01 =	116.7x24=	2800	3.73
"C"	51 x	2.01 =	102.7x24=	2460	3.28
Grain		$\frac{3.28}{3}$ or			1.09

FOR NATURAL CIRCULATION

"A" Sugar, 6.65 Strikes @ 2 Hours = 13.30 pan hours
"B" Sugar, 3.73 Strikes @ 4 Hours = 14.92 pan hours
"C" Sugar, 3.28 Strikes @ 6 Hours = 19.68 pan hours
Grain 1.09 Strikes @ 5 Hours = 5.45 pan hours
Total 53.35 pan hours

75% use factor then $\frac{53.35}{0.75}$ = 71.2 pan hours

Pans required $\frac{\text{71.2 Pan Hrs.}}{\text{24 hrs.}}$ = 2.96 say 3-10'-0" Pans

NOW, COMPARE THE SAME OPERATION

FOR MECHANICAL CIRCULATION

"A" Sugar, 6.65 Strikes @ 2.00 Hrs. x .85 = 11.30 pan hours
"B" Sugar, 3.73 Strikes @ 4.00 Hrs. x .75 = 11.20 pan hours
"C" Sugar, 3.28 Strikes @ 6.00 Hrs. x .50 = 9.84 pan hours
Grain 1.09 Strikes @ 5.00 Hrs. x .85 = 4.63 pan hours
Total 36.97 pan hours

75% use factor then $\frac{36.97}{0.75}$ = 49.4 pan hours

Pans required $\frac{\text{49.40 pan hrs.}}{\text{24.0}}$ = 2.06 say 2-10'-0" pans

From the above calculations, one (1) 10'-0" Vacuum Pan can be eliminated; or should the third Pan be equipped with a Mechanical Circulator, the capacity of the house will be increased by 50% or to 3000 tons per day.

INCREASE IN SUGAR RECOVERY

Use of mechanical circulation decreases the purity of final molasses and records show that as much as two points decrease have been obtained. The evaluation is shown in the following table.

INCREASE IN SUGAR RECOVERY

For a 1.0 decrease in Final Molasses Purity

Basis: One short ton of cane or 2000 #

Juice Purity	Final Molasses	Lbs. Sucrose extracted per ton cane		
		170 lbs.	185 lbs.	200 lbs.
75.0%	31.0%	146.57	159.51	172.44
	32.0%	145.43	158.27	171.10
	Increase Recovery	1.14	1.24	1.34
77.0%	31.0%	149.26	162.43	175.60
	32.0%	148.26	161.34	174.42
	Increase Recovery	1.00	1.09	1.18
79.0%	31.0%	151.31	165.21	178.60
	32.0%	150.93	164.24	177.56
	Increase Recovery	0.88	0.97	1.04

All sugar assumed as 97.0% Purity.

From the above a reduction of only one point in final molasses purity will increase the yield of sugar between 1.00# and 1.25# of 96° sugar per ton of cane. Applied to the 2000 ton factory, then this means an increase of 2000# to 2500# of 96° sugar per day.

SUMMARY

It has been shown that by the use of mechanical circulation the time required for the completion of a strike can be reduced; the capacity of a

Pan can be increased; the number of Pans required can be reduced; and the exhaustion of the final molasses more complete. These prove the economic value of mechanical circulation in Vacuum Pans.

ENGINEERING ASPECTS OF SUGAR MILL DRIVE MODERNIZATION IN THE HAWAIIAN ISLANDS

Joe A. Dove and Glen L. Jorn
Western Gear Corporation

On occasions, process industries experience a once in a life time opportunity--that of modernizing or expanding facilities. When this opportunity becomes a reality, you have a chance to plan, design, and build new modern facilities which will incorporate ideas gained from many years of experience, progress, know-how, and engineering development and research. This has been the situation in the cane sugar industry.

The Hawaiian cane sugar industry experienced its first steam turbine mill modernization at the Kekaha Sugar Co., Ltd., followed by similar programs at the Lihue Plantation Co., the Hawaiian Agricultural Co., the Waialua Agricultural Co., the Hilo Sugar Co., and the Ewa Sugar Co.

Back in 1951, Mr. C. H. (Harry) McAlister, Factory Superintendent of Kekaha, was given the responsibility of planning, designing, and constructing their new modern cane crushing plant. Using a combination of progressive scientific management methods and creative engineering skills, Harry McAlister set out to thoroughly analyze all aspects of the modernization, evaluate the various possibilities, and arrive at the best arrangement based on facts. Specialists of each major equipment type were consulted which included General Electric for steam turbines, Western Gear for the gear drives, and American Factors Ltd. as engineer consultant and for the overall machinery responsibility. After two weeks of conferences together at Kekaha, the above specialists agreed upon all the basic specifications, and preliminary approval was given.

Major aspects of the Kekaha conferences started with a comprehensive evaluation of whether to use group or individual drives. The decision was made in favor of individual drives to allow complete flexibility of each mill speed and load to improve production and operating efficiency. Then the horsepower requirements were very carefully considered, since this was realized as an extremely vital factor for the basis of gear drive design. Yet it was a difficult factor to determine; for the steam turbine selection requires capacity for overloads, peak loads, and high starting torques. It was not until the mill power requirements were defined in terms of average normal horsepower that the true basis was established for our gear selection. Careful evaluation of average normal horsepower requirements enabled us to select the mill drive components with ample capacity and dependability, yet avoiding excessive capacity which would add to the initial capital investment.

The next step was to examine existing Kekaha equipment to determine whether the original drives were suitable for the new conditions of increased capacity. We calculated both wear and strength horsepower ratings of the bull gear drives and inspected all components to determine their condition. We concluded that the 18 tooth pinions had inadequate rating. However, the remaining final drive components could be utilized if the bull gears were reversed and run on the unused side of the tooth profiles with new 23 tooth pinions which would provide adequate rating.

Next, the available space was ascertained so that components could be designed and selected to take advantage of the individual space conditions. From this point on, the gear drives were completely analyzed for the variety of alternate possibilities to arrive at the most favorable balance between initial capital investment, installation costs, maintenance costs, and operating efficiencies. The approach to each subsequent Hawaiian mill drive modernization followed an analysis similar to the Kekaha project with American Factors, Ltd. doing an outstanding job as engineering consultant for the overall machinery.

To the gear designer, the average normal horsepower is defined as the horsepower resulting from the average normal load which the gearing will experience from a typical season of operation. This is a distinction from steam turbine ratings that usually include reserve capacity over the average normal horsepower to handle momentary peak loads, starting loads, and overloads. Gearing and reducer selections are based on an AGMA class I rating, the average normal horsepower multiplied by a service factor. The service factor is an adjustment for shock loading and the length of time the equipment is anticipated to operate. Note that if the service factor is applied to a turbine rating rather than average normal horsepower, excessive capacity usually results which unnecessarily increases capital expenditures.

There are three broad classes of gearing utilized in mill drives. They are: (1) high speed herringbone reducers for speeds over 3600 RPM and 4000 feet per minute gear pitch line velocities (2) heavy duty herringbone reducers for speeds less than 3600 RPM and 4000 feet per minute gear pitch line velocities and (3) bull gear drives, generally spur type, under 1000 feet per minute pitch line velocity and coarse pitch.

As previously indicated, we have usually made a thorough examination of existing final bull gear drives. This included not only the gears but the rails and bearing mounts. Bull gear sets mounted with adjustable center sleeve pillow blocks are difficult to attain precision alignment, and they require constant attention to assure that alignment is maintained. Present modern gear rating methods are based on precision gear alignment, which is difficult or impractical to achieve with adjustable sleeve type pillow blocks. We recommend that a decision to use existing gearing should not be made until a complete wear and strength rating analysis has been performed based on anticipated increased horsepower and speed requirements. Many of the older drives were designed on a strength horsepower basis only. Since then, considerably more knowledge has been gained on the wear rating of gears.

Where the final bull gear drives required gear replacement, the fixed center distances between mills usually limited the size and capacity of the gearing. Obtaining the most capacity from bull gear replacement primarily depends on the following factors:

(1) Using the maximum ratio that will still provide adequate rating.

(2) Use of modified tooth profiles which provide additional rating.

For example, a 17 tooth pinion having 20 degree pressure angle stub teeth will have only about 64% as much rating as a 17 tooth pinion of the same basic pitch diameter, but with a 20 degree pressure angle full depth tooth having the most favorable long addendum modifications applied to the design.

(3) Increasing the gear hardness over existing sets. We have achieved as much as 30% rating increase on some installations from higher gear and pinion hardness combinations alone.

On the Lihue installation requiring complete bull gear drive replacement and expansion, we used a precision bored fixed center rail with the gearing mounted in anti-friction bearings. This provides a drive that has features of a totally enclosed self-contained unit which is usually achieved only with herringbone reducers but at a cost that was feasible. The constant laborious task of bull gearing adjustment was alleviated using this precision bored fixed center design.

Our next concern was the herringbone type reducers between the bull gearing and high speed gearing. Single, double, or triple reduction are possibilities here. In the majority of installations, we have found the double reduction to be most favorable.

A substantial advantage was gained by allowing the gear designer complete freedom of choice for each unit in the entire gear train. If one or more of the reducer requirements are specified by others, this prevents the gear manufacturer from taking full advantage of the most favorable standard frame sizes and the maximum utilization of capacity from each standard frame size.

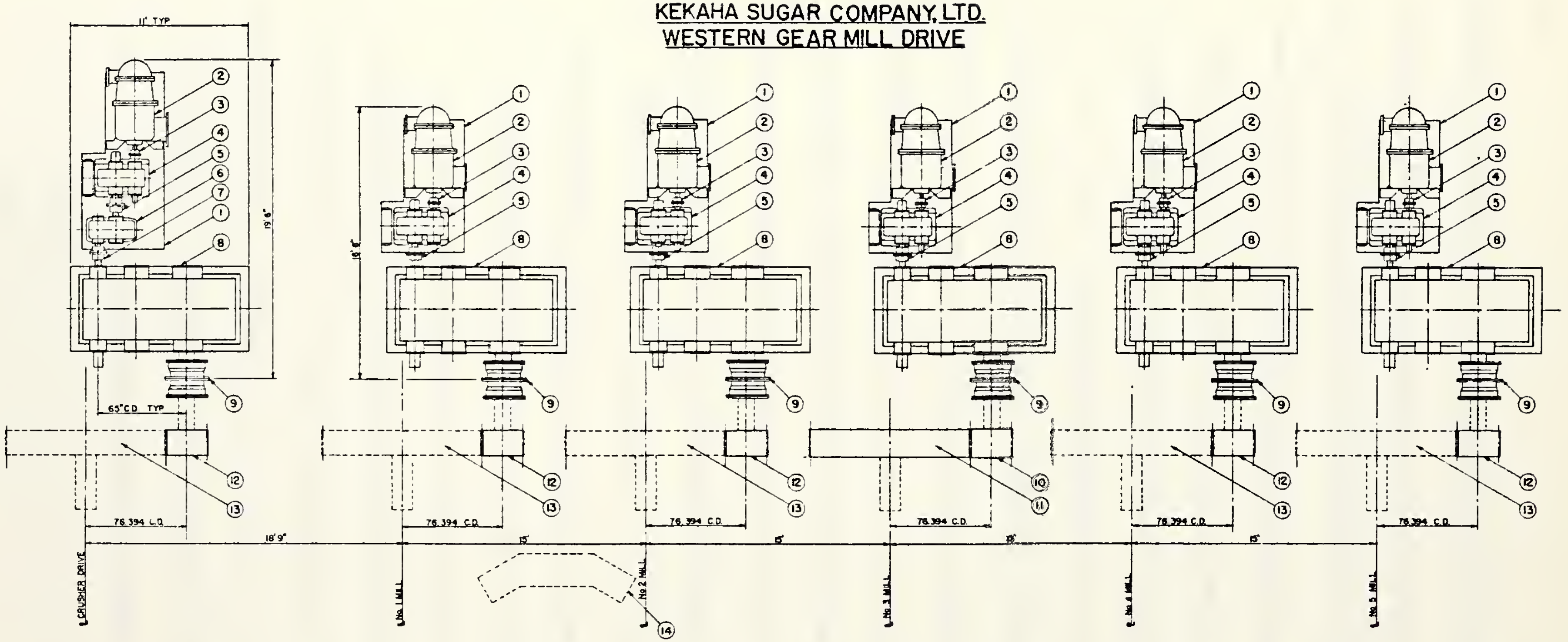
For example, if 750 HP AGMA class I rating is required, and 1000 RPM input, 33:1 ratio were specified for the intermediate reducer, the gear manufacturers standard frame sizes might rate 900 HP AGMA class I and 600 HP AGMA class I. The larger reducer would be required which has excessive capacity. This is nice from a maintenance and long life aspect but not so good from the capital investment standpoint. With freedom of choice, the gear designer can increase or decrease the ratio and input speed to take full advantage of the capacity in each standard frame. If the higher speed and ratio is chosen, the saving will not show up in the herringbone unit, but will be realized in a smaller frame sized high speed reducer which is the most expensive type of the three gearing classes.

Herringbone gear sets with adjustable center pillow blocks are occasionally considered for the intermediate gearing. However, the totally enclosed self-contained reducer offers many desirable features such as a precision gear mount not obtainable with adjustable centers, superior lubrication, higher efficiency, and lower maintenance and installation costs.

By examining all the possible standard frame size combinations between the high speed and herringbone reducers, we arrive at the most economical combination of units. A double or triple reduction high speed reducer instead of two separate units has also been a possibility for achieving capital investment and installation costs savings.

With this background, we would like to close with the following drawings which indicate the various arrangements we have designed and manufactured for the Hawaiian industry with comments on advantages and features. Each mill presents a different set of conditions so that no two installations are likely to require the same arrangement.

KEKAHA SUGAR COMPANY, LTD.
WESTERN GEAR MILL DRIVE



EQUIPMENT DESCRIPTION

① FABRICATED STEEL BEDPLATE
② GENERAL ELECTRIC MULTI-STAGE STEAM TURBINE MODEL 7TDRY42SRS, HYDRAULIC FLYBALL GOVERNOR SPEED CONTROL
③ WALDRON GEAR COUPLING
④ WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 140 HS 90, 4.75:1 RATIO, RATED 525 HP AGMA CLASS I AT 4000 RPM INPUT
⑤ WALDRON GEAR COUPLING
⑥ WESTERN GEAR HERRINGBONE SPEED INCREASER, FRAME 9-61A, 1-1.213 RATIO, RATED 582 HP AGMA CLASS I AT 842 RPM INPUT
⑦ WALDRON GEAR COUPLING
⑧ WESTERN GEAR DOUBLE REDUCTION HERRINGBONE REDUCER, FRAME DD-66M, 50:1 RATIO, RATED 525 HP AGMA CLASS I AT 842 RPM INPUT
⑨ WALDRON HEAVY DUTY MILL TYPE GEAR COUPLING
⑩ NEW PINION, 23 TOOTH, 20.5" FACE WIDTH, 4" CP, 20° PA FULL DEPTH LONG ADDENDUM, 300 BHN HARDNESS
⑪ NEW GEAR, 97 TOOTH, 20" FACE WIDTH, 4" CP, 20° PA FULL DEPTH SHORT ADDENDUM, 210 BHN HARDNESS
⑫⑬ NEW PINIONS, 23 TOOTH, 18-3" FACE WIDTH, 4" CP, 20° PA STUB LONG ADDENDUM ORIGINAL BULL GEARS AND RAILS
⑭ CUSTOM CONTROL CONSOLE FOR PUSH-BUTTON OPERATION OF MILL

MILL SPECIFICATIONS

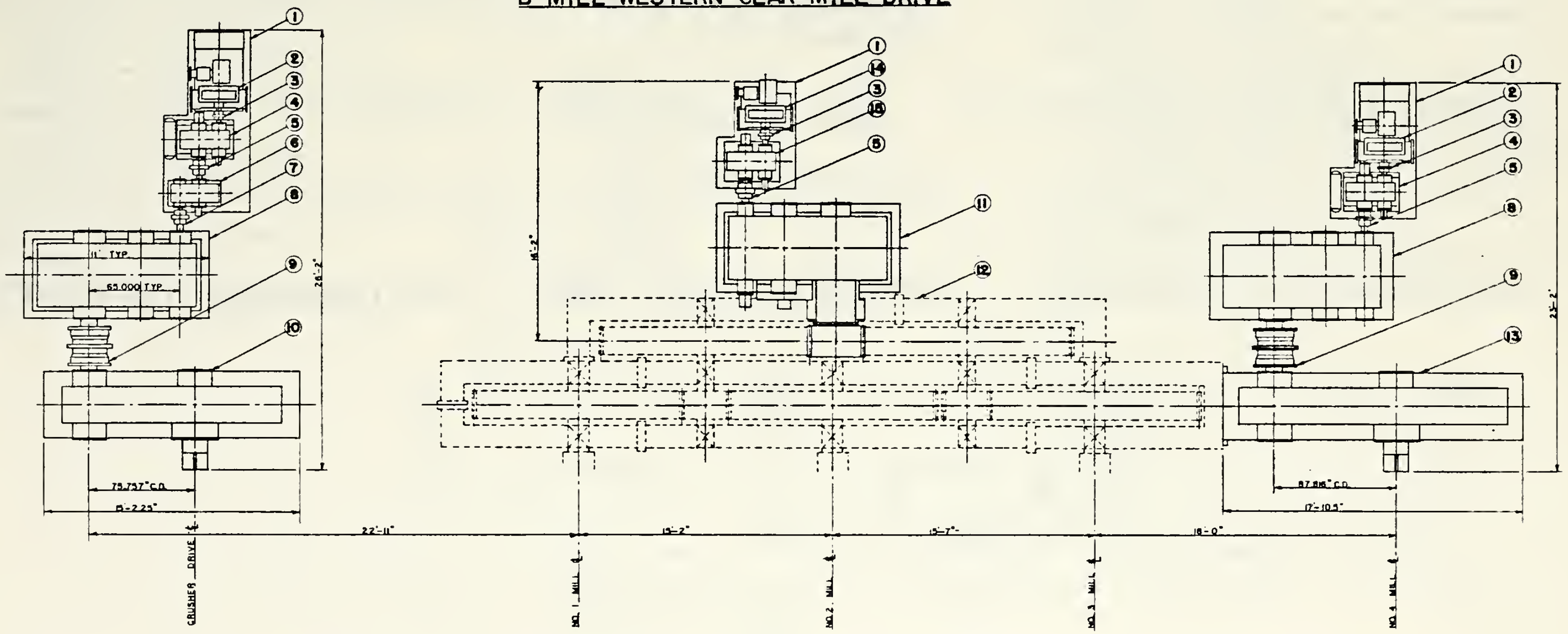
17 ROLLER MILL
TWO ROLL CRUSHER & 5-THREE ROLL MILLS, ALL 38" DIA. x 78" FACE ROLLS.
GRINDING CAPACITY
125 TONS/HR NORMAL
150 TONS/HR PEAK
RATING
300 HP AVERAGE NORMAL AT 4000 RPM INPUT, 5.5 RPM & 40 FPM CRUSHER SPEED, 4 RPM & 40 FPM MILL SPEEDS, 450 HP AT 5000 RPM INPUT FOR STARTING AND PEAK LOADS.
OVERALL RATIOS, 728:1 FOR CRUSHER & 1000:1 FOR MILLS
ROLL HYDRAULIC PRESSURE, 460 TONS NOMINAL

WESTERN GEAR
CORPORATION
SEATTLE, WASH.
MAY 21, 1959

FEATURES & ADVANTAGES

1. EACH MILL INDEPENDENTLY DRIVEN TO OBTAIN FLEXIBILITY OF MILL SPEEDS AND LOADS TO IMPROVE EFFICIENCY
2. EFFICIENCY OF MULTI-STAGE TURBINES OVER SINGLE STAGE, ELECTRIC DRIVES, OR STEAM PISTON ENGINES
3. FIRST INSTALLATION TO USE LARGE DOUBLE REDUCTION UNIT AND TOTALLY ENCLOSED GEARING UP TO FINAL DRIVE
4. MAXIMUM CAPACITY OF EACH REDUCER UTILIZED THROUGH TOTAL GEAR DRIVE DESIGN RESPONSIBILITY, LESS COST
5. MAXIMUM UTILIZATION OF ORIGINAL EQUIPMENT WITH PROVISION FOR FUTURE CAPACITY INCREASE
6. FIRST INSTALLATION WITH CRUSHER SPEED INCREASER FOR REVERSE ROTATION, ALLOWS COMPLETE STANDARDIZATION OF MAJOR UNITS
7. FIRST COMPLETELY PUSH-BUTTON CONTROLLED MILL WITH CUSTOM DESIGNED OPERATOR'S CONSOLE
8. PROBABLY THE FIRST MILL WITH CENTRALIZED LUBRICATION SYSTEM FOR OIL CONDITIONING, EQUIPPED WITH LOW PRESSURE SAFETY INTERLOCK
9. DESIGNED FOR CLEANLINESS
10. MINIMUM OF FIELD INSTALLATION COSTS, MAXIMUM OF OF SHOP ASSEMBLY AND TESTING
11. OPERATING PERSONNEL REPORT ABSOLUTELY NO LOST TIME AND NO MAINTENANCE COSTS BEYOND LUBE, OIL AND PAINT SINCE 1954 INSTALLATION

LIHUE PLANTATION COMPANY
B MILL-WESTERN GEAR MILL DRIVE



EQUIPMENT DESCRIPTION

① FABRICATED STEEL BEDPLATE.
② GENERAL ELECTRIC SINGLE-STAGE STEAM TURBINE, TYPE DR-25 CL 2
③ WALDRON GEAR COUPLING.
④ WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 140-HS90, 5.323:1 RATIO. RATED 650 HP AGMA CLASS I AT 5000 RPM
⑤ WALDRON GEAR COUPLING
⑥ WESTERN GEAR HERRINGBONE SPEED INCREASER, FRAME S-61A, 1:1.213 RATIO, RATED 535 HP AGMA CLASS I AT 940 RPM INPUT
⑦ WALDRON GEAR COUPLING.
⑧ WESTERN GEAR DOUBLE REDUCTION HERRINGBONE REDUCER, FRAME DD-66M, 30:1 RATIO, RATED 585 HP AGMA CLASS I AT 940 RPM INPUT
⑨ WALDRON HEAVY DUTY MILL TYPE GEAR COUPLING.
⑩ WESTERN GEAR FINAL BULL GEAR DRIVE, 3.58:1 RATIO, RATED 524 HP AGMA CLASS I AT 22.9 INPUT
⑪ WESTERN GEAR DOUBLE REDUCTION HERRINGBONE REDUCER WITH SPECIAL OVERHUNG OUTPUT PINION MOUNT, FRAME DD-66MS, 19.8:1 RATIO, RATED 1870 HP AGMA CLASS I AT 1400 RPM INPUT
⑫ ORIGINAL BULL GEARING AND RAILS
⑬ WESTERN GEAR FINAL BULL GEAR DRIVE, 4.5:1 RATIO, RATED 445 HP AGMA CLASS I AT 18.8 RPM INPUT
⑭ GENERAL ELECTRIC SINGLE STAGE STEAM TURBINE, TYPE DR-25 CL 2
⑮ WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 140-HS100, 3.51:1 RATIO, RATED 1680 HP AGMA CLASS I AT 5000 RPM INPUT.

MILL SPECIFICATIONS

14 ROLLER MILL—TWO ROLL CRUSHER & 4-THREE ROLL MILLS

APPROXIMATE GRINDING CAPACITY—
150 TONS/HR NORMAL
175 TONS/HR PEAK

ROLL SIZES—CRUSHER, 35" x 78"
MILLS 1-4, 36" x 78"

RATING—
CRUSHER AND No. 4 MILL—345 AVERAGE NORMAL HP AT 4500 RPM INPUT, ACTUAL OPERATION CAPACITY FOR 400 AVERAGE NORMAL HP AT 5000 RPM INPUT 6.4 RPM CRUSHER AND 4.175 RPM MILL SPEEDS
No. 1, 2 & 3 MILLS 900 AVERAGE NORMAL HP AT 4500 RPM INPUT, ACTUAL OPERATION CAPACITY FOR 1000 AVERAGE NORMAL HP AT 5000 RPM INPUT, 4 RPM MILL SPEEDS.

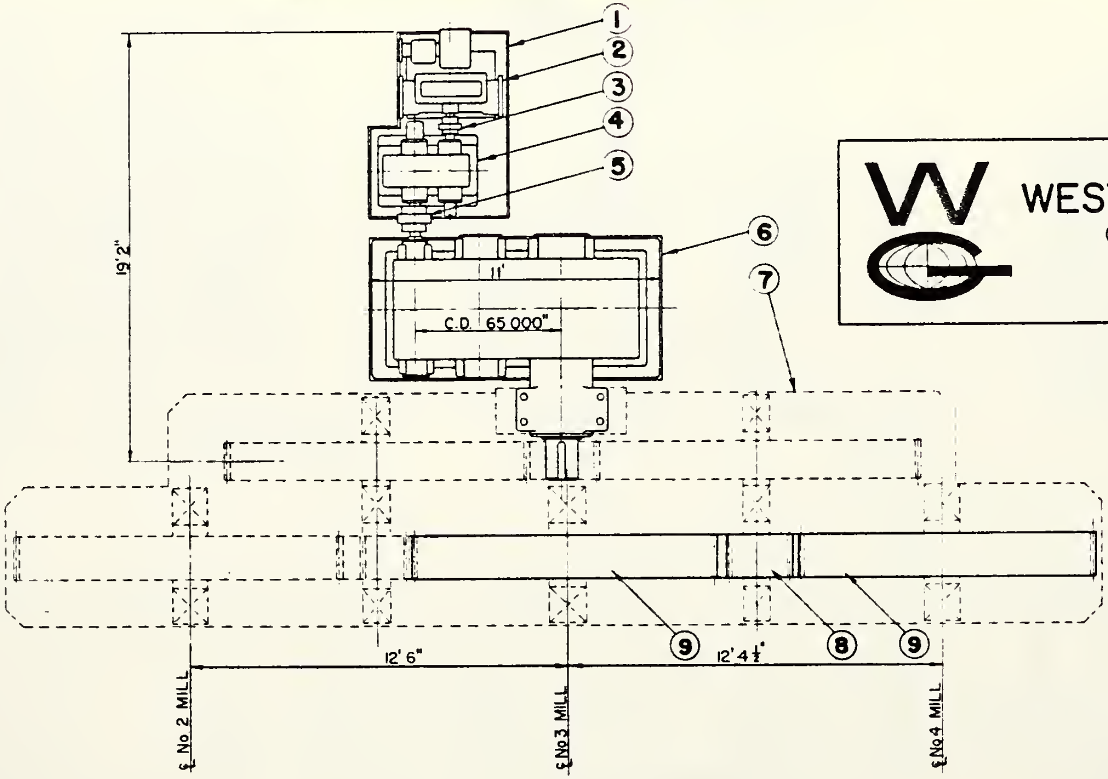
OVERALL RATIOS—
780:1 FOR CRUSHER, 1198:1 FOR NO 4 MILL AND APPROX 1250:1 FOR NO. 1, 2, & 3 MILLS

WESTERN GEAR
CORPORATION
SEATTLE, WASH.
MAY 21, 1959

FEATURES & ADVANTAGES

① THREE INDIVIDUAL TURBINES TO OBTAIN FLEXIBILITY OF MILL SPEEDS TO IMPROVE EFFICIENCY
② USE OF LARGE DOUBLE REDUCTION UNIT AND TOTALLY ENCLOSED GEARING UP TO FINAL DRIVES
③ EFFICIENCY OF TURBINES OVER ELECTRIC MOTORS OR STEAM PISTON ENGINES
④ FIRST INSTALLATION TO USE FIXED CENTER PRECISION BORED SEMI-ENCLOSED FINAL DRIVES WITH SELF-CONTAINED ANTI-FRICTION BEARINGS
⑤ FIRST INSTALLATION TO USE SPECIAL OVERHUNG OUTPUT PINION MOUNT WITH EXTENDED PAD FOR MOUNTING INTEGRAL WITH ORIGINAL BULL GEAR RAIL BEARING PAD, OVERCOMING SPACE AND MOUNTING PROBLEM
⑥ MAXIMUM CAPACITY OF EACH REDUCER UTILIZED THROUGH TOTAL GEAR DRIVE DESIGN RESPONSIBILITY, LESS COST
⑦ MAXIMUM UTILIZATION OF EXISTING EQUIPMENT WITH PROVISION FOR FUTURE CAPACITY INCREASE.
⑧ STANDARDIZATION OF UNITS WITH CRUSHER SPEED INCREASER FEATURE.
⑨ DESIGNED FOR CLEANLINESS.
⑩ MINIMUM OF FIELD INSTALLATION COSTS, MAXIMUM OF SHOP ASSEMBLY AND TESTING
⑪ NO LOST TIME AND NO SIGNIFICANT MAINTENANCE COSTS SINCE 1954 INSTALLATION

WAIALUA AGRICULTURAL COMPANY
WESTERN GEAR MILL DRIVE



WESTERN GEAR
CORPORATION
SEATTLE, WASH.
MAY 21, 1959

INDUSTRIAL PRODUCTS DIVISION

EQUIPMENT DESCRIPTION

①—FABRICATED STEEL BEDPLATE
②—MURRAY STEAM TURBINE, TYPE 141UV2
③—WALDRON GEAR COUPLING
④—WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 200 HS 110, 3.98:1 RATIO, RATED 2820 HP AGMA CLASS I AT 4500 RPM INPUT
⑤—WALDRON GEAR COUPLING
⑥—WESTERN GEAR DOUBLE REDUCTION HERRINGBONE REDUCER WITH SPECIAL OVERHUNG OUTPUT PINION MOUNT, FRAME OD 66MS, 12.53:1 RATIO, RATED 2300 HP AGMA CLASS I AT 1125 RPM INPUT
⑦—ORIGINAL BULL GEARING AND RAILS
⑧—NEW PINION, 21 TOOTH, 16" F.W., 4 5" C.P., 20° P.A., STUB LONG ADDENDUM, 285 BHN HARDNESS
⑨—NEW GEARS, 88 TOOTH, 16" F.W., 4 5" C.P., 20° P.A., STUB SHORT ADDENDUM, 210 BHN HARDNESS

MILL SPECIFICATIONS

17 ROLLER MILL

CRUSHER AND No. 1 MILL DRIVEN BY CORLIS ENGINE, 38" DIA. x 78" FACE ROLLS. No. 2, 3 & 4 MILLS AS SHOWN, No. 2 & 4 HAVE 38" DIA x 78" FACE ROLLS, No. 3 HAS 35" DIA x 78" FACE ROLLS.

No. 5 MILL DRIVEN BY CORLIS ENGINE

GRINDING CAPACITY

150 TONS / HR. NORMAL

RATING

APPROX. 1350 HP AVERAGE NORMAL AT 4500 RPM INPUT. TURBINE RATED 1500 HP AT 4500 RPM & 1650 HP AT 5000 RPM MAX. No. 2 MILL, 4.48 RPM & 44.8 FPM. No. 3 MILL, 5.09 RPM & 46.6 FPM. No. 4 MILL, 5.45 RPM & 54.5 FPM.

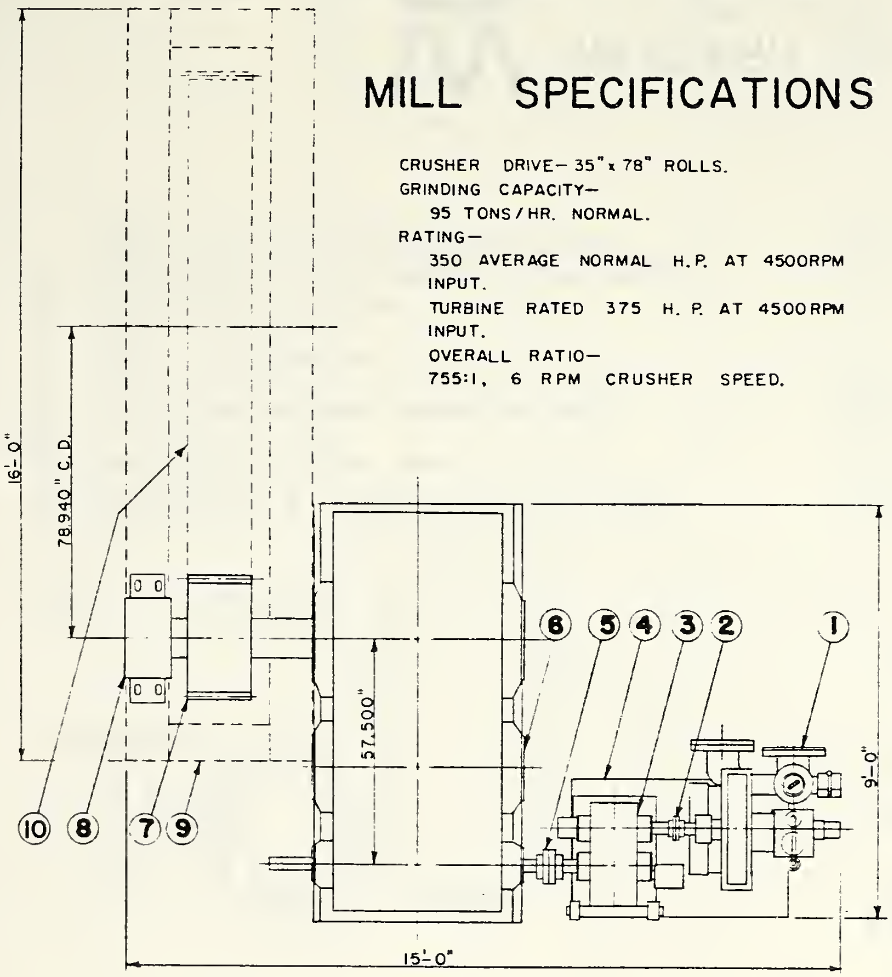
OVER ALL RATIOS

1005:1 FOR No. 2 MILL, 886:1 FOR No. 3 MILL, 827:1 FOR No. 4 MILL.

FEATURES & ADVANTAGES

1—EFFICIENCY OF TURBINES OVER ELECTRIC MOTORS OR STEAM PISTON ENGINES.
2—USE OF LARGE DOUBLE REDUCTION UNITS AND TOTALLY ENCLOSED ENCLOSED GEARING UP TO FINAL DRIVES
3—SPECIAL OVERHUNG OUTPUT PINION MOUNT WITH PEDESTAL FOR MOUNTING INTEGRAL WITH ORIGINAL BULL RAIL BEARING PAD, OVERCOMING SPACE AND MOUNTING PROBLEMS.
4—MAXIMUM CAPACITY OF EACH REDUCER UTILIZED THROUGH TOTAL GEAR DRIVE DESIGN RESPONSIBILITY, LESS COST
5—MAXIMUM USE OF EXISTING EQUIPMENT
6—DESIGNED FOR CLEANLINESS
7—MINIMUM OF FIELD INSTALLATION COSTS, MAXIMUM OF ASSEMBLY AND TESTING
8—DESIGNED TO MINIMIZE LOST TIME AND MAINTENANCE COSTS.

HAWAIIAN AGRICULTURAL COMPANY
WESTERN GEAR MILL DRIVE



MILL SPECIFICATIONS

CRUSHER DRIVE– 35" x 78" ROLLS.
GRINDING CAPACITY–
95 TONS/HR. NORMAL.
RATING–
350 AVERAGE NORMAL H.P. AT 4500RPM INPUT.
TURBINE RATED 375 H.P. AT 4500RPM INPUT.
OVERALL RATIO–
755:1, 6 RPM CRUSHER SPEED.

EQUIPMENT DESCRIPTION

① — GENERAL ELECTRIC STEAM TURBINE, TYPE DRY-125 CL-2.
② — WALDRON GEAR COUPLING.
③ — WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 95HS60, 2.6:1 RATIO, RATED 586 H.P. AGMA CLASS I AT 4500 RPM INPUT.
④ — FABRICATED STEEL BEDPLATE.
⑤ — WALDRON GEAR COUPLING.
⑥ — WESTERN GEAR TRIPLE REDUCTION HERRINGBONE REDUCER WITH L.S. OUTBOARD BEARING FOR INTEGRAL BULL PINION MOUNT TO BULL GEAR FINAL DRIVE, 69.8:1 RATIO, RATED 520 H.P. AGMA CLASS I AT 1750 RPM INPUT.
⑦ — BULL PINION, 24 TEETH, 16" FACE WIDTH, 4" C.P., 20° P.A. STUB MODIFIED ADDENDUM, 300 BHN.
⑧ — ANTI-FRICTION OUTBOARD PINION BEARING.
⑨ — BULL GEAR RAIL ASSEMBLY BY HONOLULU IRON WORKS.
⑩ — CUSTOMER'S SPARE 100 TOOTH, 16" F.W., 4" C.P., 20° P.A. STUB GEAR.

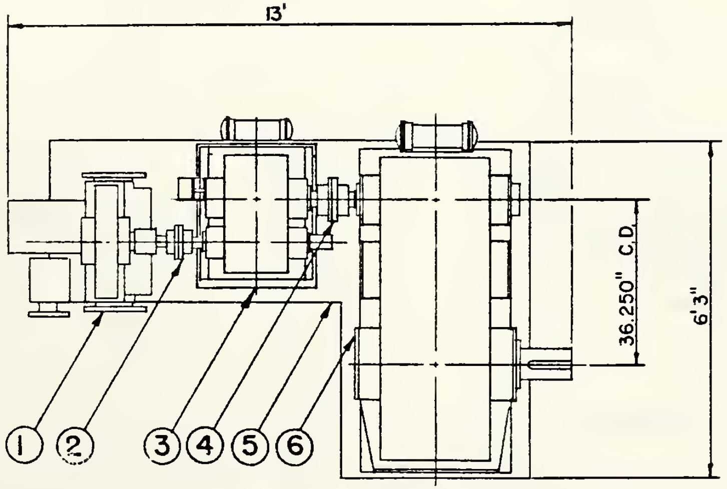
FEATURES & ADVANTAGES

① — EFFICIENCY OF TURBINE OVER ELECTRIC MOTOR OR STEAM PISTON ENGINE.
② — USE OF LARGE TRIPLE REDUCTION UNIT AND TOTALLY ENCLOSED GEARING UP TO FINAL DRIVE.
③ — SPECIAL INTEGRAL OUTBOARD BEARING MOUNT WITH RAIL FRAME, OVERCOMING SPACE AND MOUNTING PROBLEMS, REDUCING EQUIPMENT COST.
④ — MAXIMUM CAPACITY OF EACH REDUCER UTILIZED THROUGH TOTAL GEAR DRIVE DESIGN RESPONSIBILITY, LESS COST.
⑤ — MAXIMUM USE OF EXISTING EQUIPMENT.
⑥ — DESIGNED FOR CLEANLINESS.
⑦ — DESIGNED TO MINIMIMIZE LOST TIME AND MAINTENANCE COSTS.

WESTERN GEAR
CORPORATION
SEATTLE, WASH.
MAY 21, 1959

INDUSTRIAL PRODUCTS DIVISION

HILO SUGAR COMPANY
WESTERN GEAR MILL DRIVE



MILL SPECIFICATIONS

No.4 MILL DRIVE
    33" DIA. x 66" ROLLS
GRINDING CAPACITY
    58 TONS PER HR NORMAL
RATING
    325 AVERAGE NORMAL HP AT 4500 RPM.
    TURBINE RATED 375 HP AT 4500 RPM.
OVERALL RATIO
    43:1 TO BULL GEARING

EQUIPMENT DESCRIPTION

① — GENERAL ELECTRIC STEAM TURBINE, TYPE DR25-CL2
② — WALDRON GEAR COUPLING
③ — WESTERN GEAR HIGH SPEED HERRINGBONE REDUCER, FRAME 95 HS 60, 2.75:1 RATIO, RATED 550 HP AGMA CLASS I AT 4500 RPM INPUT
④ — WALDRON GEAR COUPLING
⑤ — FABRICATED STEEL BEDPLATE
⑥ — WESTERN GEAR DOUBLE REDUCTION HERRINGBONE REDUCER, FRAME OD-60, 15.6:1 RATIO, RATED 560 HP AGMA CLASS I AT 1640 RPM INPUT.

FEATURES & ADVANTAGES

① — EFFICIENCY OF TURBINE OVER ELECTRIC MOTOR OR STEAM PISTON ENGINE
② — USE OF TOTALLY ENCLOSED GEARING
③ — USE OF STANDARD STOCK FRAME SIZES FOR SIMPLICITY
④ — TURBINE OIL TANK RELOCATED TO OVERCOME SPACE PROBLEM
⑤ — MAXIMUM CAPACITY OF EACH REDUCER UTILIZED THROUGH TOTAL GEAR DRIVE RESPONSIBILITY, LESS COST.
⑥ — MAXIMUM USE OF EXISTING EQUIPMENT
⑦ — DESIGNED TO MINIMIZE LOST TIME AND MAINTENANCE COSTS.

WESTERN GEAR
CORPORATION
SEATTLE, WASH.
INDUSTRIAL PRODUCTS DIVISION
MAY 21, 1959

THE MANUFACTURE OF REFRACTORIES

Robert C. Weigel
Assistant Chief Engineer
Mexico Refractories Company
Division of Kaiser Aluminum & Chemical Corporation

Mr. Chairman, members of the American Society of Sugar Cane Technologists, and Guest, it is with a great deal of pleasure that I am here today to discuss briefly with you the general subject of "Refractories."

First, I would like to touch briefly on the history of the Refractory Industry in the United States and then move on to a complete flowsheet of the manufacturing processes, beginning with prospecting, through shipping, and concluding with a general discussion of the more recent developments affecting manufacturing methods and product application.

Although clay working is one of the oldest industries of man and has progressed through the centuries, yet its technical development has been slow compared with many other industries which might be called the "children" of modern engineering and chemical research. The older industries, such as ceramics, which started before the days of modern chemistry and physics have had the handicap of medieval methods, superstitions, trade secrets, and prejudices not known to other industries.

Up until the past twenty-five to thirty years, ceramic engineering has been particularly unfortunate in this respect. As late as 1940, practical experience and "cut and tried" methods were still the principal factors of commercial research. It has only been since the development in generalization of colloidal chemistry that ceramists have had a tangible theory of the structure and properties of fire clay materials. The industry has had to wait until modern physical chemists became interested in the great world of small particles, films and drops.

Since the firing of the first common brick, clay workers have made use of pyro chemical reactions of high temperature silicate chemistry without understanding anything but the physical results which were produced. It has only been in recent years that we began to see and understand the intricate picture of what goes on in these clay bodies during the forming, burning and using of these brick. The natural silicates are so varied and so complex that even their disentanglement has only begun. It is my feeling that this recent interest in research will pay big dividends, not only to the refractories industry in the manufacture of fire brick and related products, but you, the users of these products, will greatly benefit from the improvements yet to come.

The early history of refractories in the United States is shrouded in considerable obscurity but undoubtedly the earliest type of refractories used in this country were micaceous or siliceous rock which was quarried in various sections of the eastern part of the United States. The first successful iron furnace was built in 1645 in Massachusetts and it was probably lined with local stone of some type. Probably the first fire clay refractories used in this country were used in glass pots. The original pots made in the United States were probably of English and German clays, shipped into this country from Europe. It was early in 1800 that deposits were found in Delaware and New Jersey which were suitable for making refractory pots. Shortly after 1800, a number of different companies were organized to manufacture fire clay pots for the glass industry. We are still in doubt as to the exact location of the first American fire brick manufacturer; it may have been in New Jersey, Boston, or Baltimore. During these early times, what little firebrick were used were mainly imported from England.

It was around 1850 that a rapid growth in manufacturing took place. Plants sprung up in New Jersey, Vermont, Delaware, Maryland, Florida, Ohio, Missouri, and Pennsylvania; somewhat later other plants were located in the Kentucky, West Virginia and Colorado districts. In those early days, all of the manufacturing was by hand methods and the burning was in various types of kilns, none of which would be satisfactory for today's requirements. Digressing for a moment from the history of fire clay refractories, we find that the first silica brick were made in Akron, Ohio, in around 1866 and the first chrome and magnesite refractories were not developed in the states until just prior to 1900. It was at about this same general time, that high alumina refractories started to come into the picture.

It was from these early beginnings that the firebrick industry has grown so that today you will find plants located primarily in areas where good quality clays are found. The Missouri district is particularly blessed with the advantage of super-duty clays which are used the world over because they will do some jobs that no other brick will do. The mineral and chemical compositions are such that no other producing district can match their performance for certain specific applications.

With this brief history as a background, let us now turn to the actual business of manufacturing fire clay brick particularly in Missouri.

There are principally two main clay fields in Missouri. One is called the Northeast Central Clay District; it is actually comprised of two separate and distinct districts, one being from St. Louis out along US Highway 40 and the other in the vicinity of the Mexico and Vandalia area. The Second district is the Central Missouri District located south of the Missouri River from Rolla to Jefferson City to Hermann. In the Northeast Central District, in the vicinity of Mexico, the clays are in bed formations covering most of this region. There are places where they are very thin and the quality is very low. In the area west of St. Louis along US 40, most of the deposits are of the sink hole variety. The clays in the southern or Central Missouri District are located in sink hole type deposits and are relatively small in size and hard to find.

In the Mexico area, my company owns outright the forms on which we mine clay. In all of the other areas, we either lease the clay or own the mineral rights but do not own the surface rights. Originally clay deposits were found by outcroppings or by small grains of clay that were washed from the original deposit down deep draws or by small animals bringing the clay to the surface of the ground.

As a result of an intense prospecting program, all of these deposits that have been found are "tied up" or have been mined out. Today the location of clay deposits is much more difficult for we must lease a piece of property and then proceed to wildcat usually on 100' centers; that is drill test holes with power equipment to locate the clay bodies which may be as much as 75' to 100' below the surface of the ground.

In drilling, we use three types of drills; namely, an auger drill mounted on the back of a small truck or pulled by a tractor; the churn drill or spud drill; and a core drill. We use the auger drill for wildcatting and either the churn drill or the core drill for the final prospecting to determine the quality and quantity of the clay. After a property has been drilled, clay samples are brought to the laboratory where they are tested for melting point, shrinkage, strength and other tests to determine their value in the manufacture of firebrick.

Originally, most of the mining in Missouri was done underground but with the advent of the power machinery which we have today, all of the underground clay mines have been shut down and only open pit strip mines operate. In the stripping there are a number of methods by which it is accomplished, depending upon the formation of the overburden. In small pits a tractor scoop combination is most commonly used. In large pits, and particularly where there is heavy overburden and considerable rock structure, stripping is done with large shovels and heavy (off the highway) trucks. Most mining is done with half yard shovels where the material is either hauled by trucks directly to the plant or to a railroad for shipment to the plant. The mined clay is stored in huge stock piles and separated by quality, hardness, refractoriness and shrinkage.

At our plant in Mexico, Missouri, we have some forty different grades of clays stock piled. Two or more of these clays must be blended together to make the various quality firebrick which we produce. Some of the clays are very soft and some very hard, and therefore, it is necessary that the mine-run material on some particular clays be put through a primary crusher, which in our case happens to be a toothroll Eagle Crusher with a capacity of about 125 tons per hour.

By a series of conveyor belts, the crushed clay is transported to a dry pan where it is ground to the desired grain size. The ground clay is picked up after screening and transported by a conveyor systems to different departments throughout the plant for storage, prior to use in the manufacture of either brick or specialty products. Since most of our brick have from three to five different clays and distinct grinds (or mesh sizes) it is necessary that they be blended together and tempered to the desired moisture content before being manufactured into brick. Blending is done in a huge wet pan which is similar to the dry pan in construction but which has a solid bottom.

There are three distinct methods of manufacturing firebrick: the dry press, stiff mud, and hand molded methods. In the dry press process, the clay is ground, blended and tempered to approximately 8-9% moisture; it is fed from the storage bins above the dry presses down chutes to a charger which automatically feeds the press. I might mention that the dry presses are mechanical presses and the amount of pressure which is put on the brick being formed depends upon the volume of clay which flows into the die box. We are able to regulate the amount of clay that flows into the die box by the depth to which we drop the bottom die and this is done by a pressure wheel which lowers the position of the bottom die. Originally the movement of this pressure wheel was done entirely by hand and left entirely to the judgment of the operator. Today, the pressure wheel is activated by a motor which is controlled from a strain gauge on one of the side members of the press. By allowing a little more clay to fall into the box, we can increase the pressure and by reducing the amount the pressure is decreased. Pressures range anywhere from 1,000 to 3,000 pounds per sq. in. in properly forming the brick.

The majority of fireclay brick manufactured today are made by this dry press process which gives you a brick that is more resistant to spalling and destruction from sudden temperature changes, one which is more uniform in size and appearance, and for general purposes firebrick work is most satisfactory. Brick made by this method, however, are not as dense as stiff mud brick, nor do they normally resist abrasion as well as stiff mud brick.

The second method is the stiff-mud deaired process. In forming brick by this method, the raw clays and other ingredients going into the brick are first mixed in a dry state to insure thorough distribution of all materials. Water and binders are then added to this mix and the materials are thoroughly kneaded and cut by mechanical arms so that the end mass has all of the ingredients in intimate contact one with the other. These materials are then forced into the auger machine which has a vacuum compartment in it and all entrapped air is pulled out. The auger of this equipment then forces this mass of clay out through the dies in a continuous column. The shape of this column depends upon the particular type and shape of dies used for the particular run. It can either be in the outline of a large cupola block or a 9" straight brick or any other design desired.

As this column of clay moves along the conveyor it is automatically wire cut into slugs. These slugs pass on down the line of manufacture to repress equipment which presses these slugs to exact dimensions and applies the brand name. These pressed brick then go through a series of dryers and are burned either in periodic kilns or tunnel kilns depending upon the need of the consumer. This type of manufacture gives an end product of a very high density, one which is very resistant to abrasion and has low porosity.

The third method of manufacturing firebrick is what we term the hand-mold method, which is used for intricate shapes which are of such design or size that they cannot be made mechanically. The hand-made shape of today is quite a refinement over the hand-made brick of a few years ago because special blending and proportioning of materials is made for practically every order depending upon the final application of the special shape. I should like to point out it is not possible to attain by the hand method the uniformity, density or spalling resistance, (to mention a few of the properties) that are possible with modern mechanical methods. This is a point that many consumers fail to realize. We are presently learning how to make more and more special shapes by mechanical means to give the consumer the quality desired. One other approach that the refractory manufacturer is using today in an effort to improve product service is the replacement of special shapes by standards which can be made mechanically and which in most all cases will give better service.

After brick are made, they must be dried. In the case of dry press brick, they are set directly on tunnel kiln cars ready to be fired. In the case of stiff mud and hand-made brick they must be dried slowly in a separate drier before they can be put on tunnel kiln cars. All driers in the plant are waste heat driers that get their heat from the cooling brick in the tunnel kiln. After the brick are set on a tunnel kiln car they go through a tunnel drier where the moisture is removed to less than 1%. The cars then go into one of five tunnel kilns where they are fired up to approximately 2550°F. for a regular burn and about 2700°F. for a high fired burn. We have ten driers which contain thirty-three cars each and have five kilns which contain seventy-seven cars each. A tunnel kiln is approximately 405' long and the temperature raises in this kiln for a couple hundred degrees inside the entrance door up to 2550°F. where it remains at this temperature through about 10/12 car lengths. Then the brick are cooled over the balance of the kiln. They emerge from the kiln at a temperature where they can be handled and unloaded.

Unloading of the brick is all done by hand. Loaded on pallets the brick are handled by lift trucks and moved either to railroad cars or to storage sheds. Up until five years ago, practically 100% of our shipments were loose in cars packed in straw. Today, this type of shipment is very infrequent, and I would say that possibly 95% of all carload shipments from our plant are on pallets wrapped and tied.

The most rapidly developing field in refractories today is in the use of the so-called castable type materials. This is basically coming about because of the fact that these materials can be gun applied, can be slap trowelled or mixed and poured behind forms. Because of their ease of application and lower priced labor to install them they have always been well received in those places where their quality would permit them to give good service. Recent findings of new types of aggregates and new binders has speeded up their use tremendously. Some of these high purity castables suitable for operating at temperatures in the neighborhood of 3400°F. are permitting us to apply with ease materials which were not dreamed of ten years ago. They can be made to fit contours that brick work will not satisfactorily and economically do within reason. Some of these have excellent abrasion resistance qualities and are finding uses in cyclones and similar applications where abrasive particles are being transported by high velocity gases.

In our new knowledge of castables we are finding that we can manufacture castables with greatly improved strengths at intermediate temperatures, such as in the range of 1000°F. to 1600°F. which in the past was the so-called weak range in their strengths. There are a number of applications of this nature where these materials can be utilized to great advantage.

With regard to other speciality products, such as high temperature cements or plastic firebrick, we have long learned that those products which must have water mixed with them before final use can be much more satisfactorily prepared in the refractory manufacturer's plant where they have mechanical mixing and thorough knowledge of the desired amount of moisture which should be applied to any product. We are finding daily that factory prepared mixtures, when applied according to directions, give a much better service at less cost to the consumer than to home-made mixtures.

The present day refractory manufacturer, as I indicated before, is constantly striving to improve his product so that the consumer will benefit.

One of the major expenses in furnace maintenance is the unscheduled failure of critical areas, necessitating untimely interruptions for repair.

This can be controlled, to a major degree, by a planned program of coordinated refractory selection and application, resulting in longer furnace availability, more production and lower overall costs.

We would welcome an opportunity to outline how the Mex-R-Co plan of "Coordinated Selection" could be applied to your operation--and at no obligation.

Thank you!

PART II

STUDIES OF THE MOSAIC PROBLEM IN LOUISIANA

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The resurgence of the mosaic problem in Louisiana and some of its implications were the subjects of papers published in The Sugar Bulletin of November 15, 1958, May 1, 1959, and August 1, 1959 (1, 2, 3). The identification of a new strain of the mosaic virus in the State, losses caused by the disease in the present commercial varieties, and control measures were discussed in those papers. Results of further studies of the mosaic problem are included in this report.

Identification of Strains of the Virus

The sugarcane mosaic virus, like many other causal agents of plant diseases, occurs as several different strains. On most varieties of sugarcane, at least those grown commercially, some of the strains do not differ greatly in the symptoms they produce, although they may have markedly different effects on the growth of the varieties. However, on certain selected varieties they produce distinct symptom patterns, and it is on the basis of these differences as well as differences in certain physical properties, that they are differentiated. The new strain of the virus, which has not yet been formally described nor given a letter designation, differs from Strains A, B, and D, which also occur in commercial varieties of cane in Louisiana, in the following respects: (1) symptom pattern produced on differential host varieties; (2) lower dilution end point; (3) lower thermal death point; and (4) longer incubation period, or the time required for symptoms to appear following inoculation.

Relative Prevalence of Virus Strains

Surveys are conducted annually to determine the relative prevalence of strains of the mosaic virus on the commercial and unreleased varieties of sugarcane in Louisiana. Table 1 summarizes the surveys for the period 1956-1959. The results show that the new strain was considerably more prevalent than other strains during that period.

Factors Affecting Infectivity of the Virus

Studies of the virus with respect to strain identification, physical properties, and the relative resistance of different sugarcane varieties to it necessitate making hundreds of artificial inoculations from infected to healthy plants. Information on the effectiveness of different inoculation techniques and on the relative concentration of the virus in different parts of the plant that may be used as sources of inoculum, is therefore important. Furthermore, in studying transmission by insect or other possible vectors it is important to know to what extent the virus occurs in different plant parts. Ideally, these studies should be made with uniformly controlled light, temperature, water, nutrition, and other conditions affecting plant growth. Variations in any one of these may influence transmission of the disease. While such complete control of the environment has not been possible, some information has been obtained in the greenhouse where temperature is maintained at a minimum of 80°F. and water and fertilization are reasonably uniform.

Table 1. Identification of Strains of the Sugarcane Mosaic Virus in Louisiana 1956-1959

	NO. OF COLLECTIONS IDENTIFIED AS:					
By Varieties	Strain A	Strain B	Strain D	New Strain	Unidentified	Totals
C.P.36-105	0	0	0	3	2	5
C.P. 44-101	3	0	4	29	3	39
C.P. 52-68	0	1	0	16	0	17
N.Co. 310	0	4	1	25	4	34
Other	3	6	0	18	4	31
Totals	6	11	5	91	13	126
By Years						
1956	3	6	0	13	0	21
1957	0	0	0	9	5	14
1958	3	1	0	31	5	43
1959	0	4	5	38	3	48
Totals	6	11	5	91	13	126

Comparison of inoculation techniques. Two techniques are commonly used for inoculating plants grown from vegetative cuttings: (1) Sein's method (6), in which a strip of mosaic-infected leaf is wrapped tightly around the upper stem of the plant to be inoculated, and a fine needle used to prick up to 100 times through the infected and into the healthy tissues; and (2) Matz's modification of this method (4), in which a drop of juice extracted from a mosaic-infected plant is placed in the spindle of the plant to be inoculated, and a fine needle used to prick through the juice into the healthy plant tissues. For large scale work the Sein method has the advantage of not requiring extraction of juice, and the consequent necessity for sterilization of grinders or other extraction equipment.

In several experiments, Sein's method was as effective as the Matz method in transmitting strains of A, B, D, and F of the virus, but considerably lower transmission of the new strain was obtained by the Sein than by the Matz method. The latter is therefore being used for large scale inoculation work with the new strain.

Occurrence of virus in different parts of the plant. To determine the concentration of virus in different plant parts composite samples of juice from 5 mosaic-infected plants of P.O.J. 234 were extracted from each of the following sources: the first, second, third, fourth, fifth, and sixth unfolded leaves (counting downward from the topmost or youngest leaf); oldest green leaves; white pseudostem; and roots. Inoculations were made to young, healthy plants of P.O.J. 234 (3 weeks old and 6 to 8 inches tall). The results are shown in the tabulation below, with those from the six young leaves grouped together since there was no difference between them:

Source of virus	Plants inoculated	Plants infected
	No.	No.
Young leaves (1 to 6)	60	59
Old leaves	20	4
White pseudostem	20	18
Stem	20	6
Roots	20	8

It is apparent that virus concentration was highest in the young leaves and young stem tissue. This indicates that these are the best source of virus for extraction of inoculum. The high transmission obtained with juice extracted from the white pseudostem differs from results reported by Matz (5), who concluded that these tissues apparently contained a virus-inactivating principle.

Since the virus is present in all parts of the plant it may be assumed that insects or other animals that feed on any parts of the sugarcane plant might be capable of transmitting mosaic.

Losses Caused by Mosaic

Data from field experiments comparing yields of cane from planting mosaic-infected and healthy seed cane of 3 varieties of sugarcane are in Table 2. These results are similar to those reported earlier (2) in showing that mosaic causes greater losses in yields of C.P. 44-101 and C.P. 52-68 than in N.Co. 310. However, the disease spreads more rapidly in the N.Co. 310 than in the other 2 varieties (2).

Control

Control of mosaic by seed selection, roguing, and planting resistant varieties was discussed in earlier papers (2, 3). Where mosaic has gained such headway on a farm or plantation that disease-free seed cane can not be selected or obtained by roguing, bringing in healthy seed cane from an outside source is recommended. Good progress in mosaic control has been made by at least one plantation group by this means. County Agents and other Extension Service workers have assisted many growers in selecting and roguing their seed cane, or in locating sources from which disease-free seed could be purchased. A program aimed at providing sources of disease-free seed for growers throughout the district is being developed by the Committee on Mosaic Control of the three cooperating agencies.

Experiments conducted by Mr. Ernest Stamper of the Louisiana

Table 2. Effect of Mosaic on Yields of Cane of 3 Varieties of Sugarcane at Raceland, Louisiana. Plots approx. 1/160-acre, 5 replications.

Variety, Crop, and Year	Cane Per Acre Healthy	Cane Per Acre Mosaic Infected	Cane Per Acre Reduction by Mosaic	Mosaic in orig. healthy plots
	tons	tons	%	%
C.P. 44-101				
Plant cane, 1957	25.1	20.9	16.8	0.4
Plant cane, 1958	23.4	14.4	38.5	2.7
1st stubble, 1958	29.7	20.4	31.3	2.0
1st stubble, 1959[1]	20.2	11.2	44.6	5.8
2nd stubble, 1959[1]	22.1	11.0	50.3	12.8
5 crops	120.5	77.9	35.4	
C.P. 52-68				
Plant cane, 1958	23.1	18.4	20.3	0.0
Plant cane, 1959	27.6	16.1	41.8	0.2
1st stubble, 1959	24.4	15.7	35.7	9.0
3 crops	75.1	50.2	33.2	
N.Co. 310				
Plant cane, 1957	32.1	26.9	16.2	3.5
Plant cane, 1958	26.7	20.8	23.1	11.2
1st stubble, 1958	30.2	28.6	5.3	12.9
1st stubble, 1959[1]	13.0	9.3	28.9	12.0
2nd stubble, 1959[1]	21.0	17.5	16.7	47.4
5 crops	123.0	103.1	16.2	

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[1] Yields affected by heavy Johnson grass infestation.

Agricultural Experiment Station show the possibility of roguing by killing mosaic-infected plants with garlon. This may be faster and cheaper than digging out and destroying the diseased plants, especially in stubble cane.

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STANDARDS OF CANE QUALITY IN RELATION TO AGRONOMIC RESEARCH AND COMMERCIAL EVALUATION OF MILL CANE

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International Research Service

Any criterion of cane quality must be based essentially on the ratio of available sugar to cane. However the choice of system for quality evaluation can be greatly influenced by conditions under which the standard is to be applied. Since this paper relates primarily to the contrasting requirements of: (a) agronomic research and (b) factory management, I should like first of all to show how some of the basic differences can affect the choice of method.

Evaluation of cane quality as a factory problem must necessarily be in terms of absolute values in reference to a specific lot of cane. But in agronomic research we are concerned primarily with relationships between experimental variables, and here accuracy of comparison in a relative sense is of greater importance than a precise determination of absolute values. I am not belittling the importance of precision in research but it must be emphasized that actual measurements of cane per acre and sugar per ton of cane are merely the final phase of a series of experimental procedures. It is easy to see that no degree of precision in this last step could compensate for bias or other inaccuracies introduced by reason of faulty methodology in the research approach.

Results of an experiment made some 30 years ago and reported in an earlier paper (6) will illustrate this point.[1] I was attempting to arrive at the most accurate way of determining average juice analysis on approximately 20 tons of P.O.J. 213 distributed over 12 replication plots of 1/20 acre each. Four samples of 50 stalks each were taken from each plot, and the customary analyses of primary juice were made on individual samples. The overall average indicated yield of sugar per ton of cane amounting to 167.2 pounds could be duplicated within a statistical accuracy of +1/4 pounds by taking a random sample of 50 stalks from each of the 12 plots. By contrast, 24 samples of 50 stalks each assembled by taking 4 samples from each of the first 6 plots gave an average indicated yield of 162.2 pounds of sugar per ton of cane, as compared with 172.2 pounds based on the average of 24 samples similarly taken from the last 6 plots. It could be shown further that a bias of nearly 10 pounds of sugar per ton of cane induced obviously by soil differences would have persisted in a comparison of the entire lot of 9.94 tons of cane from the first six plots with the 9.64 tons from the last six. Thus merely increasing the compared quantities of cane without proper safeguards to prevent bias could in fact increase rather than decrease errors of comparison. In view of sampling errors underlying the latter two sugar yield determinations, any refinement in analytical procedure to delimit computed values to several decimal points, for instance, would be obviously ridiculous.

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[1] Numbers in parenthesis refer to literature cited.

In my work here in Louisiana I faced the problem of testing sugarcane varieties varying widely among themselves in fiber content as well as in juice composition. It was evident from the outset that primary juice analyses alone would not suffice for valid varietal comparisons. Some means had to be found to make appropriate adjustments for varietal differences in fiber content.

The method eventually developed has been described in previous reports (2, 3, 8). To review briefly, small but highly comparable samples of sugarcane are milled to commercial levels of extraction under carefully controlled conditions. The operation including multiple milling with uniform maceration gives a reasonably good simulation of factory milling. Sucrose extraction ordinarily ranges from 93 to 95%. From a knowledge of weights of (a) cane, (b) extracted juice and (c) bagasse, together with the customary analytical information on crusher juice, mixed juice and bagasse it is possible to calculate all essential milling data.

The important information to be derived from such tests is an estimate of the effect of varietal differences in milling qualities on the indicated yield of available sugar as determined from crusher juice analyses. Essentially the problem is this: Given a set of factors appropriate for estimating the yield of available sugar from Variety A, what adjustments must be made in the case of Variety B differing significantly from Variety A in juice extraction and other milling qualities?

In resolving such an adjustment to a mathematical basis we integrate into a single factor the combined effects of varietal differences in (a) normal juice extration % cane and (b) drop in purity between primary crusher juice and normal juice. Details of the calculation have been published (8). In actual practice we assume a uniform Brix reduction factor, hence a difference in purity drop is reflected directly in the sucrose (pol) reduction factor.

All important commercial and experimental varieties were repeatedly tested in comparison with Co. 281, and a correction factor in accordance with the above was determined in each case. This has been designated as the varietal correction factor. In effect it makes an appropriate adjustment in calculated available sugar per ton of cane for difference in fiber content between the particular variety and Co. 281, the control.

Such milling tests conducted at the Houma Station over more than 25 years have supplied a wealth of basic data from which it is possible to make a critical evaluation of the system and its application to agronomic research. Detailed results and our interpretations based on appropriate statistical analyses have been published (1, 2, 3). Essential generalizations may be summarized as follows:

(a) The correction factor for any given variety may be regarded as essentially a constant under Louisiana conditions. It has been found statistically the same whether calculated on plant cane or stubble and was not significantly affected by soil or other environmental variables. Experimental variations are relatively small as indicated by a variability coefficient of 1.7%.

(b) Relatively small lots of cane (80 pounds) are satisfactory for milling studies if appropriate precautions are taken to minimize sampling errors. Our cane for such studies ordinarily came from plots of group experiments where plot-arrangement designs employed to overcome effects of soil heterogeneity ensured highly comparable varietal samples.

(c) An increase in fiber % cane caused reductions in normal juice extraction and sucrose reduction factor both tending to reduce the varietal correction factor. The overall relationship is such that given a varietal fiber % cane in relation to a control value it is possible to compute the varietal correction factor with reasonable accuracy. In an earlier paper (1) it is shown that V.C.F. values calculated from the following equation did not differ significantly from ones computed from results of milling tests:

$$B_{cf} = -0.02265$$

in which B_{cf} is the linear regression of departure in V.C.F. from 1.00 on departure in fiber % cane from that of the control.

(d) Fiber content of any given variety, will vary from test to test and it is recognized that calculated sugar yields based on generalized extraction factors could depart from actual values in individual cases. However in view of the demonstrated constancy of V.C.F. values, this will have no important effect on calculated differences between varieties and that is essentially the purpose of a variety test.

As a routine procedure, the calculation of varietal sugar yields from unreduced Brix (B) and % Sucrose (S) values is greatly facilitated by use of the following simplification of the Winter-Carp Formula: Yield of sugar per ton of cane equals Sx minus By. The mathematical derivation of x and y from basic premises assumed in the formula and the method of their adjustment to correct for varietal differences in milling qualities are discussed in previous publications (7).

For variety Co. 281 under our conditions of experimental milling x = 21.5017 and y - 6.2383. Thus given a crusher juice analysis of Brix 16.50 and sucrose 13.40% the indicated yield of 96° sugar per ton of cane is calculated to be (13.40 x 21.5017) - (16.50 x 6.2383) = 185.2 pounds. In the case of a variety with a correction factor of .94, x = 20.2116 and y = 5.8640. The indicated yield of 96° sugar per ton of cane would be (13.40 x 20.2116) - (16.50 x 5.8640) = 174.1 pounds at the same crusher juice analysis.

It may help to bring the problem in better perspective if we remember that in comparing varieties of sugarcane for field production and milling value we are dealing primarily with 3 distinct variables, viz.:

(a) Production of cane per acre

(b) Composition of the juice

(c) Fiber content of the cane

In an earlier paper (2) we have reported a coefficient of variability averaging approximately 9% with highly significant locality, crop and year interactions in experimental measurements of varietal production of cane per acre under the U.S.D.A. program here. It was concluded that repeated tests on different crops (plant and stubble) at representative locations over a period of years are necessary for reliable comparisons. Juice composition in terms of available sugar content was substantially less variable (C.V. approximately 4%) but was found of sufficient importance, especially with respect to interactions to demand a program of essentially as extensive as required for cane yield measurements. Thus a concurrent determination of both cane production and juice composition in the same series of field tests is the obvious answer.

Available sugar per ton of cane depends on the quantity of extractable juice and its composition. In conducting variety tests this information could be obtained on samples of cane from each experiment but such a scheme would be laborious and costly. In the usual procedure, available sugar per ton of cane is determined from an analysis of primary (crusher) juice but we have recognized that varietal differences in fiber content could introduce an important bias in the comparisons. Varietal milling studies described above were directed at the question: "Is it possible to remove the resulting bias through appropriate generalized corrections?" Our answer is Yes.

In a comprehensive statistical analysis, varietal correction factors such as defined above maintained a relatively low variability coefficient as given earlier and showed no significant interactions with localities, crops or years under Louisiana conditions. The obvious conclusion is that such a factor can be generalized with accuracy. An average value based on 10 to 15 determinations is considered sufficiently accurate for the purpose of agronomic research.

The important underlying fact is that varietal fiber content in a relative sense is a highly stable character, hence any bias introduced in routine sugar yield calculations by reason of varietal differences can be essentially removed through appropriate correction constants. Such a bias will be inversely related to difference in fiber content, and according to our results, will approximate 2.265% for each percentage point in the difference. Thus in the case of a variety with fiber content of 14.5% when the control contains 12.5%, the basic amount of available sugar per ton of cane calculated from primary juice analyses would have to be reduced by 4.53%. This would require a varietal correction factor of 0.9547.

The system we follow in determining varietal correction factors directly from milling results provides for concurrent determination of fiber values. This gives us a good check on experimental accuracy.

It may be of interest to note here that the Houma Station system of varietal mill-quality control is being successfully used in other countries. A group of American companies operating 9 centrals in Cuba are applying this system in their cooperative project of varietal research. The method is also being used at Central Romana in the Dominican Republic. In both cases P.O.J. 2878 serves as control, and it is considered significant that varietal correction factors as determined in Cuba have not differed greatly from ones determined on the same varieties at Central Romana (9).

Coming now to the question of cane quality as a problem in factory operation, determinations of potentially available sugar, and also of recovered sugar per ton of cane can be readily made on a day's run or a season's operation as a routine calculation in a modern system of factory control. But individual lots of cane reaching the factory in a given day may vary greatly in milling value, and this is especially true where the supply includes varieties of contrasting qualities. Procedures followed in determining available sugar for the purpose of factory control are obviously not applicable to small lots of cane.

Factors primarily considered in estimating potential factory value of separate cane deliveries are:

(a) Composition of the juice (pol and Brix).

(b) Quantity of extractable juice per ton of cane - the latter ordinarily an inferential value based on fiber content. Other qualities of secondary importance such as clarification properties of the juice and varietal properties of fiber as affecting the milling operation are recognized, and in individual cases may attain considerable importance but these are not ordinarily considered in routine mill quality determinations. A relatively high percentage of fiber in cane apart from its effect on extractable juice, will reduce the rate of milling and would ordinarily be considered undesirable. However, it would conceivably become an asset where there is an advantageous commercial outlet for surplus bagasse.

The C.C.S. Formula of Queensland and the S.E. Formula ("sucre extractible") of Reunion are typical of the ones developed to compute available sugar on relatively small lots of cane. Each one takes into consideration analysis of primary juice and fiber content of cane.

According to the Queensland Formula C.C.S. =

$\frac{3P}{2}(1 - \frac{5 + F}{100}) - \frac{B}{2}(1 - \frac{3 + F}{100})$ (12) page 16.

C.C.S. = Commercial cane sugar
(basis, recovered sucrose % cane)

P. = pol of primary juice

B. = Brix of primary juice

F. = Fiber % cane

The Reunion Formula is stated as follows (10):

$$S.E. = K \cdot B_1 \frac{(P_1 - 30)}{100} (1 - 1.4F)$$

where

S.E. = Recoverable sugar (basis, 97° sugar % cane)

B_1 = Brix of crusher juice

K = Factory coefficient ranging from 1.2 to 1.3

P_1 = Purity of crusher juice

F = Ratio of fiber to cane

The Houma Station equation is comparable to the two formulas above mentioned in that it attempts to estimate available sugar per ton of cane from primary juice analyses with adjustments for differences in fiber content. It is of interest therefore to compare the 3 methods in their application to representative data. The table below gives indicated available pounds of 96° sugar per ton of cane at 3 levels of fiber % cane assuming a primary juice analysis of: Brix 16.00, and % sucrose (pol) 13.00 in each case. Values according to the Houma Station method were calculated with basic values of x = 21.5017 and y = 6.2383 at 12.41% fiber in cane. At other levels of fiber content adjustments in x and y were made in accordance with the regression equation given earlier.

Pounds of 96° sugar per ton of cane at primary juice analysis of: Brix 16.00; % sucrose (pol) 13.00 according to:

Fiber % cane	S.E. method of Reunion at K = 1.3	Houma Station Method	C.C.S. Method of Queensland
9	188.3	193.6	202.7
13	176.2	177.3	193.1
17	164.2	161.0	183.5

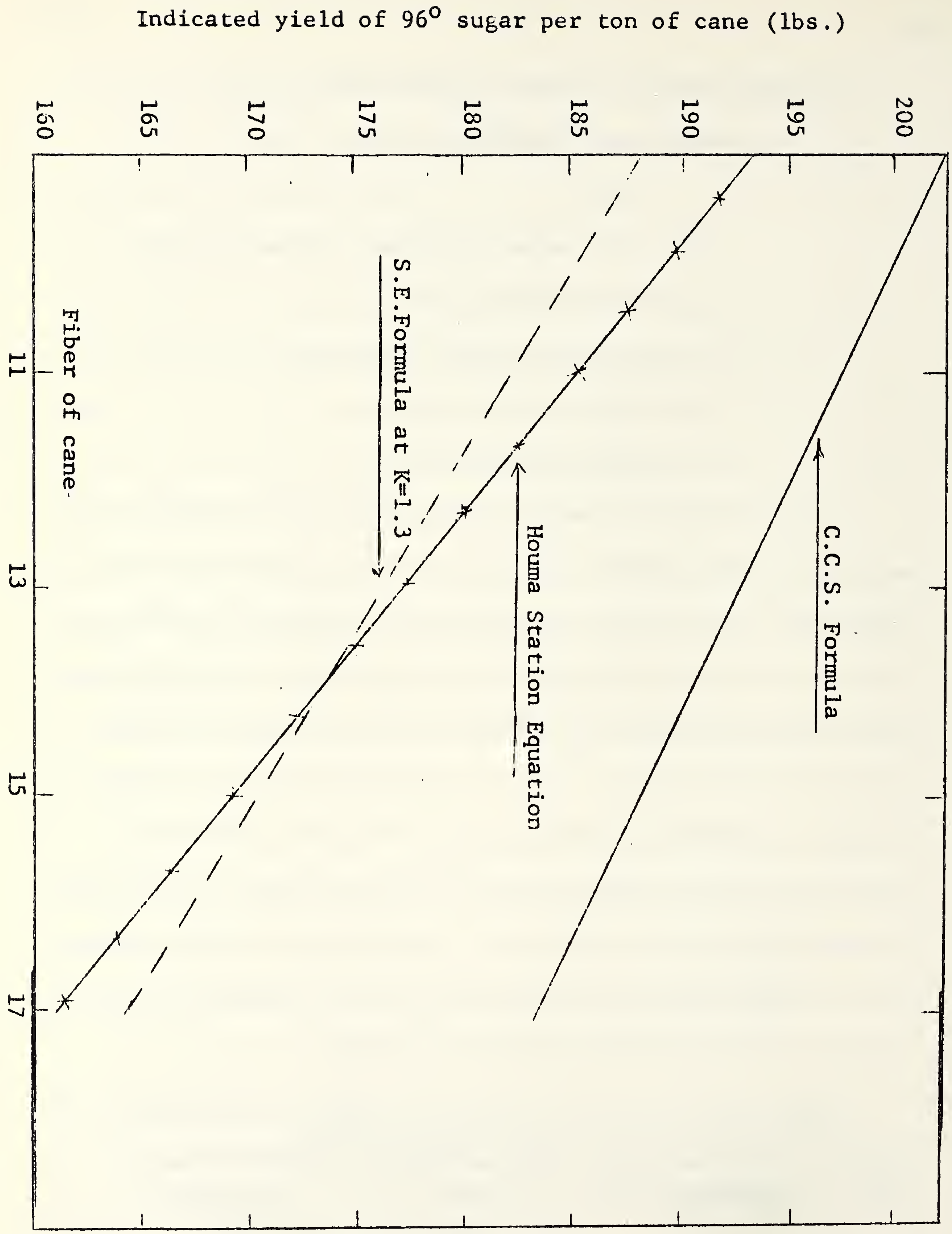

Fig. 1. Sugar Recovery according to each of 3 Formulas at Different Levels of Fiber % Cane with Primary Juice Analysis at Brix 16. and % Sucrose (pol) 13.

Data given above are shown graphically in Fig. 1.

Comparisons between the Reunion and Houma Station formulas are of special practical interest in that each one attempts to make a realistic adjustment for the effects of fiber. It will be noted that at 9% fiber, available sugar per ton of cane according to the Houma Station method is slightly higher than the S.E. value and that the opposite is true at 17% fiber. At the assumed analysis of primary juice the Reunion method shows a drop of 24.1 pounds in available sugar per ton of cane with an increase from 9 to 17% fiber in cane as compared with a decrease of 32.6 pounds according to the Houma Station method. In other words we place a greater penalty on fiber. An important reason is that our method adjusts for an increasingly greater drop in purity between primary juice and normal juice with an increase in fiber % cane. Also the S.E. Formula assumes a constant 5% loss of sucrose in bagasse, whereas in our results the percentage loss of sucrose in bagasse has increased with an increase in fiber % cane. It is interesting to note, however, that within the more usual range of fiber in cane between 12 and 15%, indicated sugar yields according to the two methods differ very little.

The S.E. and C.C.S. formulas serve as standards in the purchase of cane in Reunion and Queensland respectively. Here in Louisiana the mill value of cane is based essentially on composition of normal juice as calculated from the analysis of primary juice. An adjustment is made for percentage of trash in cane but the existing arrangement does not make any allowance for differences in percentage of fiber in cane proper.

I need not elaborate here on difficulties of determining mill value of cane under present Louisiana conditions. I am sure we can all agree that primary juice analysis and fiber content of delivered cane would not tell the whole story. Our situation unfortunately is greatly complicated by trash. Difficulties of measuring the percentage of trash in cane are bad enough, but after the ratio of trash to cane has been determined we are still faced with the problem of arriving at just how much mischief trash does in milling and fabrication operations. In this connection I would like to refer to a study of this particular problem we made during 1944.

In a series of small-scale milling tests such as employed in measuring varietal milling qualities, we started out with highly comparable samples of clean cane each weighing 80 pounds. Some samples were milled free of trash to serve as controls and others were milled with various quantities of added trash. In one series, the effects of adding 2 1/2, 5 and 7 1/2 pounds of dry trash respectively were determined, and in the other series green trash was added in amounts of 6, 12 and 18 pounds respectively. Fiber content of dry trash averaged approximately 85% and that of green trash approximately 33%, thus each step of trash-increase in each case had the effect of increasing fiber % clean cane by slightly more than 2%. Results of this study have been published (5) but it may be of interest to review here some of the pertinent findings:

(a) Added trash increased measurably by the loss of sucrose in bagasse, but the loss was not as great as would have been expected from a corresponding increase of fiber in the cane proper.

(b) The most important effect of trash was a reduction in normal juice purity due to a substantial increase in nonsucrose solids. This was especially true of green trash. The following tabular presentation gives some of the essential data derived from 7 determinations in each case:

Treatment (Pounds of Trash added)	Pounds of sucrose (pol) in bagasse per ton of trash-free cane	Pounds of non-sucrose solids extracted per original ton of cane				
		Ash	Nitrogen	Other non-sucrose solids	Total	
					Pounds	% of check
0	10.0	10.68	.53	37.78	48.99	100
2 1/2 Dry	10.9	11.30	.54	38.96	50.80	104
5 Dry	12.2	11.24	.55	40.93	52.72	108
7 1/2 Dry	13.3	11.61	.55	41.03	53.19	109
0	10.2	10.73	.54	37.61	48.88	100
6 Green	10.1	12.15	.61	44.01	56.77	116
12 Green	10.7	13.65	.71	49.23	63.59	130
18 Green	12.1	14.90	.79	52.26	67.95	139

The addition of green trash equaling 22 1/2% of the cane weight increased the extracted non-sucrose solids per ton of cane by 19.07 pounds. According to the Winter-Carp equation this would result in the loss of 7.63 pounds of sucrose (19.07 x .40). But actually we have no basis for making such a deduction. Effects of the particular impurities involved on sugar recovery could be substantially different from that of the usual assortment of impurities extracted from the stalk proper.

At this point it may be of interest to review results of a study made in 1948 (4). From an analysis of my experimental data in comparison with state-wide factory results prior to 1944, I was able to develop a factor to predict with reasonable accuracy the state production of sugar per ton of cane from results with certain key varieties at representative locations.

The following tabulation shows that predicted values are in relatively good agreement with actual factory recoveries during the period 1936-1944 inclusive:

Average yield of 96° sugar per ton of cane

Year	State av. (actual)	Predicted state av.	Actual minus predicted
1936	161.02	160.90	+ 0.12
1937	154.42	157.14	- 2.72
1938	168.96	170.21	- 1.25
1939	173.50	173.96	- 0.46
1940	161.98	166.14	- 4.16
1941	165.28	160.69	+ 4.50
1942	171.44	169.21	+ 2.23
1943	164.06	162.42	+ 1.64
1944	152.54	156.30	- 3.76
1945	151.37	161.85	-10.48
1946	155.96	175.90	-19.94
1947	150.40	172.30	-21.90

However, as shown by the remainder of the data, when the same factors are used to predict factory recoveries during the period 1945-1947 inclusive there are wide discrepancies that become increasingly important from year to year. The change in varietal use during the period could not account for indicated deficits in sugar recovery.

Fig. 2 gives a graphical comparison of predicted and actual factory recoveries for Louisiana during the period 1936-1947 inclusive.

Fig. 3 gives annual average values for fiber % cane for the period 1935-1947 as based on Louisiana factory reports. Shown also are estimated annual values for the Louisiana crop as varietally constituted with the cane milled entirely free of trash. In arriving at the latter we assumed a composite value for the crop as a whole adjusted on the basis of proportionate acreages of the various varieties in cultivation and their respective levels of fiber content as determined in experimental milling tests.

It will be noted that the difference in fiber content between mill cane and that estimated for the crop free of trash was relatively small at first and became greater and greater over the period. This trend is clearly apparent in the following grouping of annual results:

Period	Average departure of fiber % cane as milled from value estimated for clean cane
1935, '36 & '37	+ 0.07
1938, '39 & '40	+ 0.80
1941, '42 & '43	+ 1.24
1944 & 1945	+ 1.50
1946 & 1947	+ 2.10

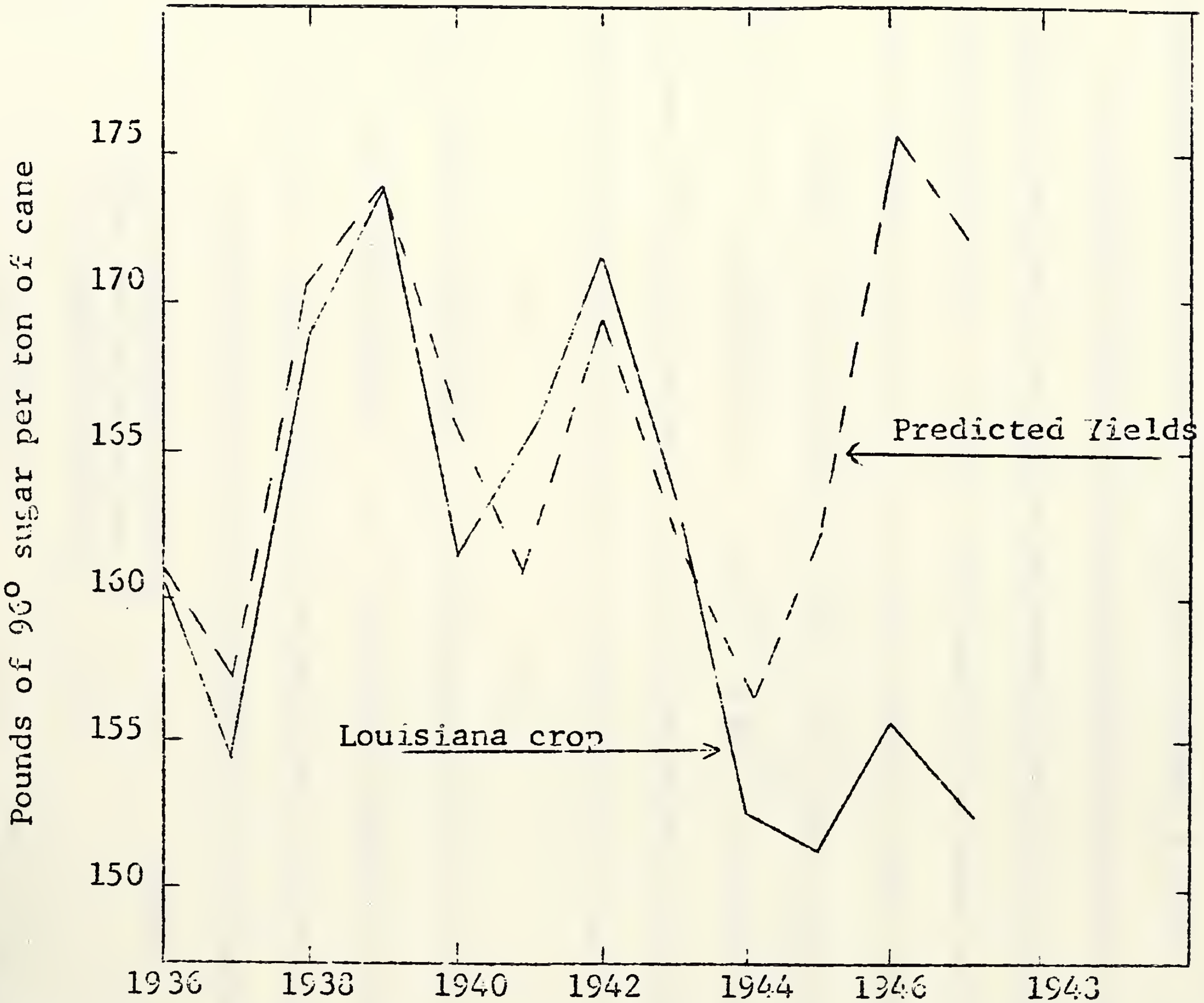

Fig. 2. Average annual yields of sugar per ton of cane in Louisiana compared with predicted yields based on experimental performance of index varieties.

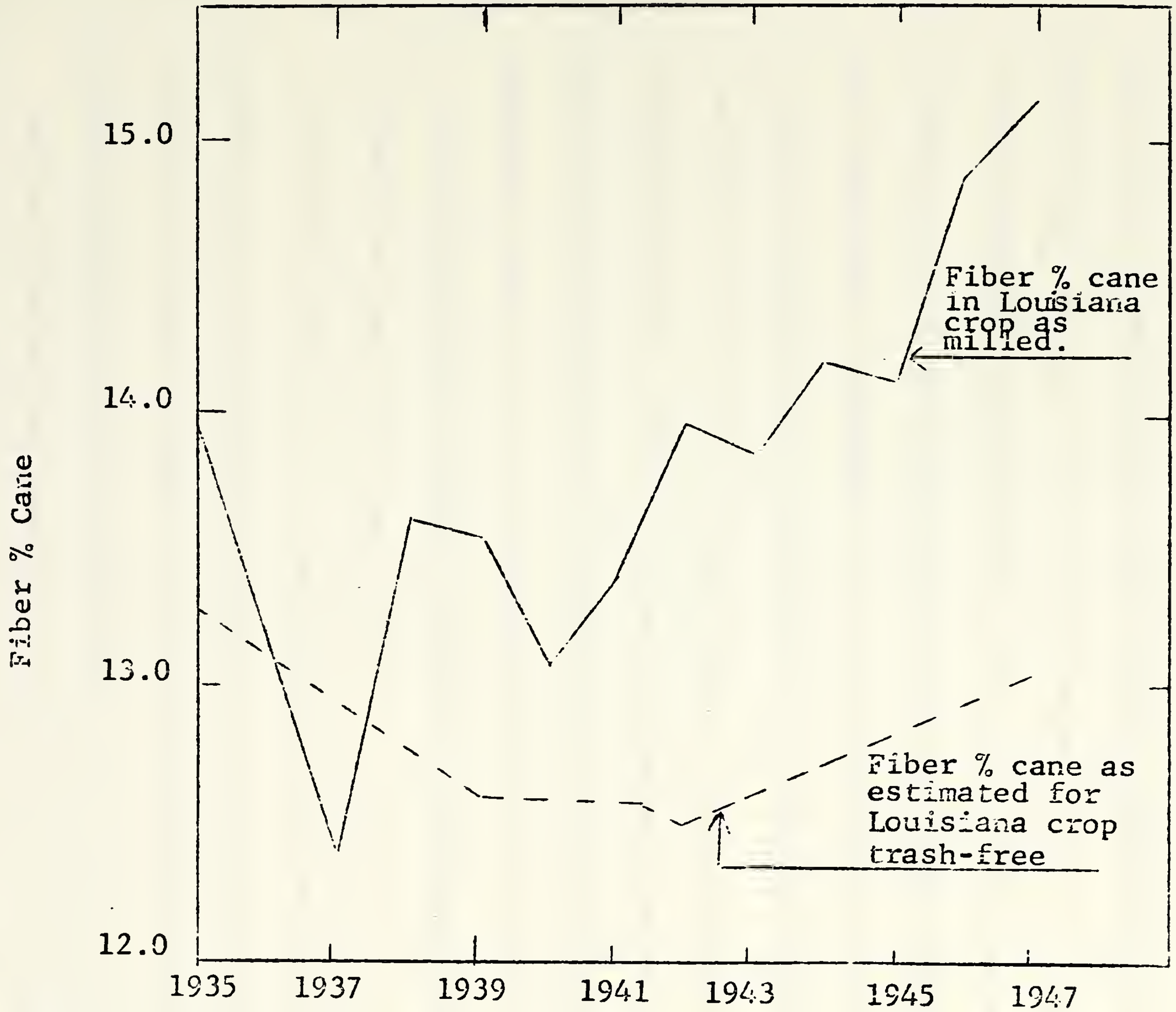

Fig. 3. Annual values for fiber % cane of Louisiana Crop (a) as milled and (b) trash-free, the latter estimated on the basis of varieties in cultivation.

There is no doubt that the above figures reflect the greater and greater quantities of trash being sent to factories with the cane over the period involved.

According to data presented above, the Louisiana crop showed an indicated average production deficit of nearly 21 pounds of 96° sugar per ton of cane during 1946 and 1947. During the same period, fiber % cane as delivered to the mill exceeded the calculated value for trash-free cane by an average difference of 2.10%. We have no figures on trash content for these two crops but a value of approximately 4% may be estimated from the computed excess fiber in cane. Converting, on that basis, the quantity of cane ground to net tons, reduces the discrepancy between predicted and actual sugar yields to approximately 14 1/2 pounds per ton. According to results of our previously cited studies (5) presence of trash in such proportion would probably not account for a loss of that order in the milling operation. In my opinion, other factors associated with mechanical harvesting played a major part in the calculated depression of sugar recovery. I have in mind such causes as inversion of sucrose in cut cane prior to burning, and deterioration of burnt cane, especially from fermentation under moist conditions; also from unselective topping of mechanically cut cane. Keller and Seip have shown that departure of average crop quality from experimentally indicated values as determined above was closely associated with spread of machine harvesting (13).

As regards the question of mill-quality standards, having been out of direct touch with the Louisiana Industry since 1951, I would hesitate to offer concrete suggestions. I am sure we can all agree that the presence of trash in mill-cane presents a real problem. There is first of all the task of securing a truly representative sample. Dr. Keller has this particular problem under direct study (11) and his progress so far leads us to hope that an accurate and practically workable sampling technique will eventually be developed.

But after a good sample has been taken there is still the problem of what to do with it. In the ideal system, should we determine the trash ratio, mill the clean cane separately and apply appropriate adjustments for trash? Or should we mill the sample as is and evaluate it on the basis of extractable juice and its composition? In either case, I am sure you will agree that there is need for much basic research before a workable system can be developed. Additional information will be required especially as regards impurities contributed by various kinds of trash and their effects on fabrication efficiency before an accurate adjustment can be applied for ratio of trash to cane.

Use of the entire sample for quality determinations will require juice extraction to customary commercial levels. In my opinion use of our small-scale milling technique with standardized maceration could have an important place in such an approach.

Coming now to the over-all question of cane quality under present Louisiana conditions, our thinking in reference to mechanization of harvest has been dominated by the unquestionable reduction in direct costs of the operation. I am afraid that in failing to evaluate fully some of the negative factors, such as the above, we may have lost perspective in our understanding of the problem. I am not condemning mechanical harvesting. It is here to stay and we must learn to live with it. But it would not be unreasonable to set up as an ideal a condition whereby losses from improper topping, field deterioration, and trash in the factory would be essentially eliminated. To meet these requirements completely, cane would have to be selectively topped, mechanically cleaned and delivered directly to field transport units. A big order indeed! But a potential gain in cane quality of the order indicated would certainly justify a big effort to that end.

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THE AGRICULTURAL SIGNIFICANCE OF MISSISSIPPI RIVER DEPOSITS

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The principal significance of Mississippi River deposition to the agriculturist in the lower valley is its role in spreading soil parent materials laterally across the flood plain. In order to better understand the differences in physical characteristics of the soils of the lower valley, it is necessary to discuss the ways in which the river deposits and the kind of deposits it drops at different places across its valley floor.

Various types of deposits are found on the floor of the lower Mississippi Valley. Within present and abandoned river channels coarser-grained materials from the river's sediment load have been dropped because they are heavier and thus the first to come to rest when the river slows at low water stages. These coarser sediments, mainly sands and very fine gravels, lodge on bars on the insides of bends and on sandy islands within the channel called towheads. When the river overtops its banks in flood, the velocity and carrying power of the water are reduced at the point where the water first overflows the bank. A low ridge called the natural levee is formed at this point along both sides of the river. The materials forming this ridge are composed of fine sands, silts and a lesser amount of clay giving a sandy loam or silty clay texture with good drainage, since the natural levee has relatively steep slopes on the channel side and a long backslope from the crest inclining gradually away from the channel. The width and height of the natural levee depends on the size and suspended load of the stream depositing it. In the case of the Mississippi, both the size and the suspended load are great. Therefore, the natural levees it builds are immense, being a mile or more in width and 15 to 20 feet high.

By the time the flood waters from the river have reached the backswamp basins between natural levee systems, their velocity has been greatly reduced and most of the coarser particles have been dropped in the channel or on the levee. Since only the fines are still in suspension when waters are finally pounded in the backswamps relatively fine silts and clays are deposited there. Consequently, soils are a great deal heavier in texture, have poorer drainage because of flatter slopes and do not allow as free water penetration as do levee soils. Decay of vegetal material and erosion of levee backslopes by rain and levee crevassing by the river and materials to the backswamp deposits also.

Rivers that meander, that is, swing from one side of their valley to another through the lateral migration of an S-shaped channel pattern, also build-up broader ridges known as meander belt ridges (Fisk, 1944). Along any given course of the Mississippi there is a belt across which normal lateral channel migration takes place (Matthes, 1946). Only when the river adopts a new course because of a major diversion does it deposit outside this belt (Fisk, 1944). Therefore, along any given course of the river, the land within the meander belt is gradually built higher than the surrounding parts of the flood plain. These higher areas remain as ridges long after the river has abandoned a meander belt and adopted another.

Meander belt ridges contain a greater variety of deposits than do natural levees. Very sandy point bar deposits, silty and sandy levee deposits and fine-grained channel filling material compose a meander belt ridge.

Knowledge of the physical properties of fine-grained alluvial deposits of the Mississippi Valley can be of value to the agriculturist. The physical properties of meander belt deposits are well known from borings, analysis of surface samples and field observations. The deposits contain very fine-grained clays, silty clays and "blue mud" in channel and slough fillings, fine silty sands, clayey silts and silty clays overlying previous sands and gravels of point bars, and natural deposits which vary from sandy silts and silty clays to clays and silty clays. The grading of natural levee deposits is more consistent than those of any other meander belt deposits (Fisk, 1947). The sand content decreases and the clay content increases down the back-slopes of levees and from north to south along the valley. The water content of sediments constituting channel fillings varies from 20% to over 150% (Fisk, 1947). The clays and "blue muds" found in the thickest portions of channel fillings have the highest water content and the sands usually found in the upstream end of abandoned channels have the lowest water content (Fisk, 1947). Point bar deposits generally have a low water content since they are the most porous of all meander belt deposits. Natural levees are similar to the finer grained topstratum of point bars in water content, but retain somewhat more water than the coarser grained lower strata of point bar deposits.

Backswamp or floodbasin deposits are very fine-grained, cohesive and plastic and display the greatest uniformity of grain size of all the deposits under discussion (Fisk, 1947). They consist of interbedded, thinly layered clays and silty clays with frequent lenses of "blue mud," and minor amounts of silty sands and clayey sands. These deposits contain a high organic content derived from the decay of the abundant vegetation growing in backswamps.

The fine-grained alluvial deposits of the lower Mississippi Valley vary chemically as well as physically. Since natural levee and bar deposits are exposed to the atmosphere more frequently and for longer periods of time than backswamp and channel fillings, they are more thoroughly oxidized to greater depths. Furthermore, because they are better drained and leached, they are less acid than channel fills and backswamp clays. The presence of less vegetation and a different type of vegetation also contributes to the less acid nature of the levees. Channel fills and backswamp deposits are formed in a chemical environment of reduction. Channel fills are more chemically reduced than backswamp deposits, partially because of their greater water content and partially because of their shorter periods of exposure. Backswamp deposits are often somewhat oxidized near the surface and on their margins because these areas are frequently exposed when drying occurs in fall and early winter. The oxidized portion of backswamp clays can be easily identified by their typically reddish-brown or grey color. "Buckshot" clay pellets are frequently formed at or near the surface because of exposure and drying. The most reduced and least oxidized deposits of the backswamp are the "blue muds" which are laid down in lakes or old channels and have not been periodically exposed. These, likewise, are the most acid of backswamp accumulations.

The implications in the facts so far discussed are important to the agriculturist. There is a great variance in the agricultural value of land from one type of alluvial deposit to another in the lower Mississippi Valley. Generally speaking, the best agricultural lands are found on the natural levees where there is superior drainage, soil texture and chemical composition making it possible to grow a wide variety of crops. Next in suitability comes the old bar deposits and channel fills. Least desirable of all from an agricultural viewpoint are the backswamp deposits because of their density, heavy texture, acid content, frequent waterlogging and extra high organic content.

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IMPROVEMENT IN MILL ENGINE SPEED CONTROL AT CALDWELL SUGAR CO-OPERATIVE

V. J. Bailliet

The efficiency of our governor on the engine driving our third and fourth mill at Caldwell was perhaps worse than on the average installation but we believe that what we did to improve the situation should be of interest to all operators of Corliss engines, driving mills or crushers. Of course those of you who are not affected by mud and trash conditions and therefore set their mill speed the first day of the crop and then forget it until the next crop should have no governor problem, but we are not of those lucky few.

Flyball governors are most stable and exert their greatest corrective force when operated within a very narrow speed range and Corliss engines actually are designed to operate at constant speed. The practice of moving the counterweight according to speed change demand is at best a "make-do" practice because it actually sets strains and stresses in the governor linkages conductive to undue wear. At any rate this practice should be limited to small speed changes since the governor becomes sluggish when rotating at a speed too far away from its optimum RPM. When the conditions require a mill speed change of more than 10 or 15% the correct governor RPM should be restored by changing the ratio of flywheel RPM to governor RPM, and heretofore the only way to accomplish this was to: first--stop the mill, second--remove the pulley on the governor shaft, third--install another pulley, fourth--add or remove a section of the flat transmission belt. At best it takes 10 minutes to accomplish this.

Actually the problem is to drive a constant speed shaft from a variable speed source of power which is mechanically the same as obtaining variable speed RPM from a constant RPM source of power. We are all familiar with this mechanism as we have it on our vacuum filter drives, clarifier drives, clarifier pump drives, maceration pump drives, etc.

The first thing we did was to determine the optimum speed of the governor shaft. Then we installed a Reeves Variable Speed Transmission and selected the proper pulley diameter to install on one shaft to be driven by the belt from the crankshaft. On the other shaft of the transmission we mounted a sprocket, and on the governor shaft.

Engine speed change is now accomplished in a matter of seconds by turning the handwheel on the Reeves Transmission. The governor runs accurately at the same speed at all times. Hunting is completely eliminated. Engine speed is very steady. Mill room operation is improved.

The installation can be improved further and allow mill control from a central control board as is done where turbine drives are used. An electric remote control and a trachometer are added to the Reeves Transmission and the operator can check his mill speed at a glance and change the speed without leaving his post.

We were not the first sugar mill to use a Variable Speed Transmission to control the engine speed. In 1950 the South Puerto Rico Sugar Trading

Company installed three new large engines all equipped with a Reeves #3 transmission one 42" x 60" at Guanica and two 44" x 60" at Central Romana in the Dominican Republic. Incidentally, these two have a 50-ton flywheel. All three installations include the electric remote control, the tachometer.

The engineers report that the systems are very satisfactory and that maintenance in 9 crops of 4 to 6 months each has been limited to annual cleaning and inspection on only the transmission, controls and governors. Needless to say that after 41 days at Caldwell, we too, have had no maintenance.

We will, however, make one minor change, which will be from a flat belt to a roller chain for the drive from the engine crankshaft to the transmission shaft, as we have found that sometimes the flat belt slips.

We feel that the few hundred dollars we spent will be well returned by the reduction in lost time and the increase in mill efficiency due to the easy adjustment of the engine speed required to maintain the optimum roll speed.

EVAPORATOR EXPLOSIONS

Arthur G. Keller

Explosions in sugar factory evaporators are quite rare. When two explosions occur in the same area and within a few months of each other it is unique and news worthy. This report deals with such explosions which occurred in Louisiana in August and October, 1959.

A triple effect evaporator exploded at the Sterling Factory of Franklin, Louisiana in August, 1959. The circumstances surrounding this case were reported as follows: A used cast iron triple effect evaporator acquired from the Loisel Factory at Jeanerette had been installed and was being checked for leaks when an explosion occurred in the second body which severely damaged both the second and third vessels. The exact cause of the explosion has not been positively determined. The circumstances surrounding the event and a possible explanation follow.

The evaporator bodies were being filled with water to test the new installation for leaks. Water was supplied from a stagnant pond using a centrifugal pump. The calandrias of all three bodies were first filled and then the liquor and vapor sections. A four inch charge line was used for filling. When the water level in the number two body reached the four inch boil-out opening at the top of the vapor section, orders were issued to close the charging line and at the same time the boil-out line was closed. Several men were working around the evaporators checking on leaks. About forty-five minutes after the water lines had been ordered closed there was a serious explosion.

A 36" diameter 90° elbow at the top of the second vessel failed. A piece of metal roughly 2 feet square was blown out of the elbow. This struck an auxiliarry vapor line to the third vessel wrenching it loose from the calandria of the number three body. Apparently the force of the explosion caused the bolts holding the dome of the number two vessel to the vapor belt to fail. The massive dome turned 90° in a vertical plane, landing in the now open vapor section and shattering it. The calandrias of bottom number two and number three bodies were cracked. The tubes and tube sheets suffered no apparent damage. None of the personnel around the scene of the accident was injured despite the severity of the damage.

The exact cause of the explosion is not known. Several theories have been advanced to account for it. Two will be examined here. The most obvious explanation would be that the water supply to the vessel was not turned off as ordered and that excessive pressure build up caused the explosion. A check on the maximum pump pressure available in the vessel was of the order of forty pounds gage. With a slow build up of water pressure it is reasonable to suppose that there would have been failure or damage to the tubes or tube sheets in either body since these are weak points in the system. No damage was evident. The charge valve was found to be in good condition and closed.

There exists the possibility that a flammable mixture of marsh gas (methane) might have built up in the vessel and been ignited. It was noted that the water used for filling the vessel was emitting gas bubbles in the supply pond. The explosion occurred about the same time that a summer thunder show took place. It appears possible that a gas explosion could have occurred.

The second explosion occurred at the Levert-St. John Factory of St. Martinville in October. In this explosion damage was more severe but miraculously no one was injured. The circumstances were as follows.

A cast iron double effect evaporator from the Loisel Factory had been installed in parallel with the second and third bodies of an existing triple effect evaporator also of cast iron construction. This construction required considerable modification of vapor lines serving the station. New lines were of welded steel construction.

The new installation was cleaned with caustic soda after construction was completed and during the factory try-out period. Some vapor line leaks were noted at this time. Following completion of the cleaning with soda the vessels were emptied, rinsed with water and then charged with dilute acid for a further cleaning. The plant crew were working a single eight hour shift at this time. It was not possible to complete the acid cleaning on Thursday as planned so the solution was allowed to remain in the vessels overnight. The evaporator manholes and boil-out lines were open.

Prior to resumption of the cleaning procedure the following morning, a welder was instructed to close a leak in the mild steel vapor line above the number three body at a point next to the condensor. When he struck an arc the explosion occurred.

Damage to equipment was severe. Neither the steel vapor line, the condensor nor the welder were damaged. It is to be noted that the vapor line communicated with the original third body and with the second body of the new installation. The catchall was broken loose from the third body and the vapor section of the body thrown against the number two vessel. The bottom was blown out of this cast iron vessel.

The new installation was also severely damaged. A cast iron separator in the vapor line was shattered. The bottom was blown out of this cast iron vessel also.

Figure I* is a picture of the steel vapor line taken after the explosion. The welding rod protruding from the line marks the leak in the line which was to be repaired. Note that the line is undamaged.

Figure II* is a view of the cast iron separator of the third body. The unit was blown into this position by the explosion. Note the diaphragm which closes the exit of the separator. This is part of a light metal baffle from the interior of the separator. The manner in which it is blown upward shows that the explosion occurred below the separator. The probable explanation of the explosion follows.

The dilute acid in contact with the iron vessel liberated hydrogen gas. This gas which is only 1/14 the density of air rose and filled the vapor liner, and condensor of the unit displacing air downward as it did so. Over the period of 12 to 14 hours the condensor, vapor lines, and separator probably filled with relatively pure hydrogen. Below the boil-out opening the vessel was filled with a mixture of hydrogen and air. Pure hydrogen will burn quietly with an almost colorless flame. Hydrogen air mixtures in most ranges are powerful explosives.

The welders arc ignited the pur hydrogen escaping through the hole in the vapor line. The flame travelled down the vapor line until it reached the hydrogen-air mixture which exploded with the results noted.

There are two obvious lessons to be learned from these explosions.

1. All evaporators should be equipped with safety valves or rupture discs of ample capacity to handle normal steam or water pressure excesses.
2. When using acid for cleaning, maintain good ventilation in the equipment and keep open lights and fires away.

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*Figures not included for publication.

THE APPLICATION OF THE EIMCOBELT FILTER FOR THE FILTRATION OF CANE MUD BASED ON OPERATIONS AT THE DUGAS & LE BLANC, LTD., WESTFIELD FACTORY

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PREFACE

The purpose of this report is to indicate the operation of the first successful continuous drum vacuum filter employed on the filtration of underflow from cane mill juice thickeners, using a cloth filter media and producing a filtrate acceptable for evaporation.

An acknowledgment is extended by the authors to personnel of Dugas & LeBlanc, Ltd. and the Eimco Corporation for assistance in installing, operating and evaluating the first Eimco Belt filter which was installed in the Westfield Factory of Dugas & LeBlanc, Ltd. for the 1959 crop. In particular, sincere thanks are given to Frank Voight, Chief Engineer and Technical Superintendent of the Westfield Factory, for his many constructive comments regarding the EimcoBelt filter.

I. INTRODUCTION

An important part in the manufacture of raw sugar in a sugar cane factory is the purification of the juice which results from grinding and maceration of the sugar cane.

One of the most important purification steps is clarification, where the primary object is to remove from the juice the maximum quantity of impurities by gravity sedimentation following liming and heating of the juice.

The juice is limed to neutralize the organic acids present and to minimize the rate of sucrose inversion by maintaining an approximately neutral pH. In raising the temperature of the limed juice to 200°F or above, the formation of a heavy precipitate of complex composition results. The precipitate contains insoluble lime salts, coagulated albumin and varying proportions of fats, waxes, and gums, in addition to quantities of colloidal dirt and sand. The precipitate and any settleable unflocculated matter settle under quiescent conditions in a clarifier.

Quiescent conditions are made possible by tray-type clarifiers which minimize floor space requirements and also minimize heat loss. Overflow from the tray-type clarifiers may pass to additional clarification processes such as sulfitation or it may pass directly to evaporation. The underflow from the clarifiers contains approximately 85 percent by weight liquid and because of the quantity of sucrose dissolved in the liquid, the liquid must be recovered.

Historically, plate and frame filter presses were used to separate the solids from the liquid in the underflow streams. Due to high labor and operating costs, the plate and frame filters were replaced by continuous drum-type vacuum filters. The vacuum filters are equipped with perforated copper or stainless steel filter media. The blinding tendency of a portion of the solids contained in the clarifier underflow prevents the use of tight media (such as the cotton duck filter media employed on the plate and frame filter presses) on the drum filter. Consequently, the filtrate from the continuous filter would contain a portion of the solids originally contained in the filter feed. This portion of the solids would be resettled by feeding the filtrate back into the clarifiers and this constitutes a recirculating load of solids. Eventually, under ideal conditions, these recirculated solids would be removed by the drum filter by being retained on the mat of bagacillo (the fine solids fraction of the exhausted cane which is added to the clarifier underflow and used as filter aid) which would be formed on the perforated screen.

The use of the continuous drum vacuum filter therefore necessitated additional clarification volume for resettling the solids present in the filtrate. Usually 10% of the volumetric feed to the mill juice clarifier is present as underflow and as most of this flow would be present in the filtrate streams, the required additional clarification capacity would be close to 10% or greater. However, as the solids present in the recirculated stream were particles finer than average, the re-sedimentation of these solids would require greater than normal volumes of sedimentation per volume of fluid. Therefore additional settling capacities as high as 25 percent would be required when an excessively "dirty filtrate was recirculated back into the clarifier.

Operational problems with the perforated screen filter (hereafter referred to as standard filters) have greatly increased in magnitude with the advent of mechanical harvesting. Under conditions of hand cutting and loading, the quantity of field mud present in the clarifier underflow stream would be less than if mechanical cutting and harvesting were employed. The quantity of solids to be removed by the standard filters increased and because the additional amount of solids were predominantly fine particles, the amount of solids present in the filtrate increased. The greater filtrate solids concentration would sometimes cause sedimentation difficulties and clarifier overflows would become contaminated with solids. Therefore as the cane increased in mud content the recirculated solids loading would increase and cause severe sedimentation problems which could only be eliminated by additional clarification capacity. Sugar mills that did not have the required additional clarification capacity would be forced to slow production and thereby decrease the quantity of sediment to be removed or they could periodically "dump" some of the clarifier underflow at substantial monetary loss.

To cope with the problem of recirculating solids, plate and frame pressure filters and leaf-type pressure filters have been installed to handle the filtrate from standard units and thereby obtain a solids free liquid. Also, some cane sugar mills have even replaced the standard filters with plate and frame pressure filters--despite the realized high operating and maintenance costs of this batch-type filter.

The problem of separating the solids from the liquid in the underflow could be eliminated by a filter which would:

1. Separate the suspended solids from the liquid in the underflow stream and produce a filtrate which would go directly to evaporation. Therefore the filtrate would have a clarity comparable to clarifier overflow.
2. Operate continuously.
3. Produce a filter cake low in moisture and sucrose.
4. Minimize maintenance costs by extending filter media life.
5. Maintain a non-blinded filter media.
6. Be simple to operate and not require continuous maintenance.
7. Have no blow-back of filtrate as the filter cake is discharged.

Recent improvements in the methods of continuous filtration, as a direct result of the accelerated growth of process industries and in this particular instance, the cane sugar industry, have been made. One such improvement is the EimcoBelt continuous vacuum-type drum filter. The design of the EimcoBelt filter continuously removes the filter media from the drum surface and conveys the media over a set of rolls and then back on the filter drum. The removal of the filter media from the drum surface permits:

1. Continuous washing, if necessary, of the filter media to maintain a non-blinded filter media.
2. No blow-back of filtrate when the cake is discharged.
3. Complete discharge of a dry filter cake and no scrapers required to remove the filter cake.

The original development of the EimcoBelt filter is based on pilot plant investigations as early as 1954. The acceptance of the EimcoBelt filter is evident in the installment of over 60 filters since the start of the initial pilot plant investigations.

Research and development into the application of the EimcoBelt filter on the filtration of cane "muds" was initiated by pilot plant investigations using a four square foot of filtration area filter. Test work with this filter was conducted in Louisiana and Florida during the 1956 campaign. Results were encouraging and led to the installation of the first commercial sized EimcoBelt filter in the cane sugar industry through the cooperative efforts of Dugas & LeBlanc, Ltd. and the Eimco Corporation. Installation of a 10 foot diameter by 12 foot face EimcoBelt in the Westfield Factory of Dugas & LeBlanc, Ltd., Paincourtville, Louisiana was made in time for the 1959 campaign.

This report describes the operation of this EimcoBelt filter for the filtration of mill juice clarifier underflow during the 1959 campaign. Also, this report includes the marketing of this type filter in the cane sugar industry as confined to the United States market.

II. WESTFIELD FACTORY FLOW SHEET

The Westfield Factory of Dugas & LeBlanc, Ltd. is located in Paincourtville, Louisiana, and it is rated at 3300 gross tons of cane per 24 hours.

Operation in the Westfield Factory produces raw sugar and molasses.

Virtually all of the sugar cane is mechanically cut and loaded.

The sugar cane is milled by a 17-roll tandem, consisting of a two-roll crusher and five sets of three-roll melts.

As shown by Illustration 1, maceration is employed using sweet water, and the mill juice is screened prior to liming in batch tanks which also serve as measuring tanks. The juice is limed cold and after liming, passes through heat exchangers at a flow rate of approximately 500 GPM.

Three mill juice clarifiers are employed:

1. One 20 foot diameter 5-tray clarifier
2. One 20 foot diameter clarifier
3. One 18 foot diameter 3-tray clarifier

Overflow from the mill juice clarifiers go directly to triple effect evaporators. The clarifier underflow streams pass to a sump. Overflows from the three mud filters and also the underflow from a special 14'8" diameter by 7' high filtrate clarifier pass to the previously mentioned sump.

Into this sump, lime is added which increases the pH of the filter feed and thereby improves filtration rates, minimizes cake moisture, and minimizes percent sucrose in the filter cake.

From the sump the mud is pumped to a single mixer equipped with a horizontal paddle. Bagacillo, which is used as filter aid, is added to the mixer and comes from a 40 square foot screen on the first section of the bagasse carrier and also from a 40 square foot monel screen, with 1/8" holes, on the second section of the bagasse carrier.

Flow from the bagacillo cane mud mixer is passed to any or all of three filters:

1. One 10' diameter x 12' face (377 $ft.^2$) EimcoBelt.
2. Two 8' diameter x 14' face (350 $ft.^2$ each) Standard Perforated-Screen Type Filters.

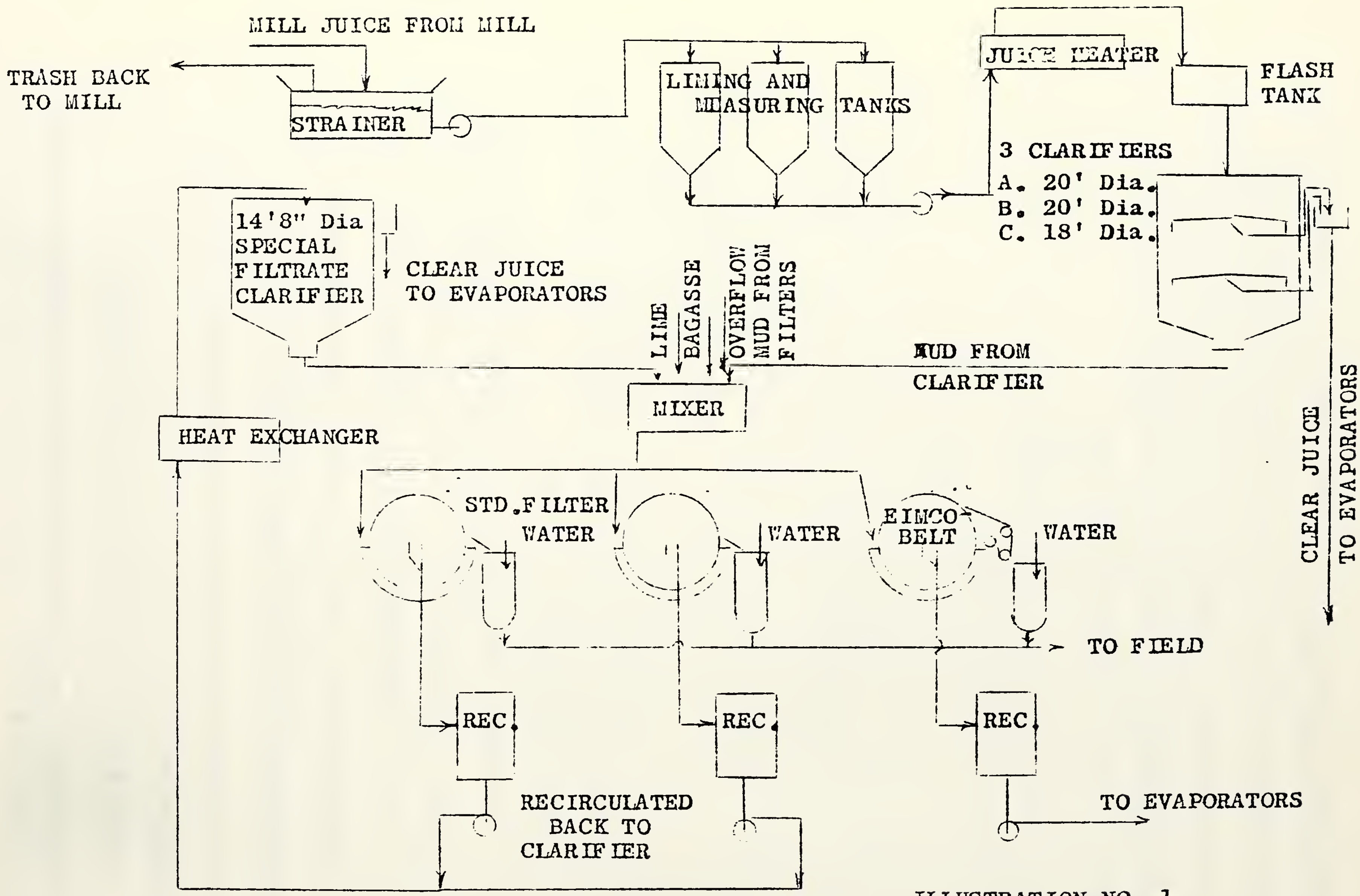


ILLUSTRATION NO. 1

FLOW SHEET FOR

WESTFIELD SUGAR FACTORY

PAINCOURTVILLE, LA.

The EimcoBelt Filtrate passes directly to the evaporators, whereas filtrate from the standard filter passes through a heat exchanger and then into a special filtrate clarifier. Overflow from the filtrate clarifier goes to the triple-effect evaporators.

Piping is installed whereby the filtrate from the two standard units may go to the liming and measuring tanks - in case the filtrate clarifier cannot handle the load.

The filter cakes are washed to recover additional juice and the discharged filter cake repulped and pumped to cane fields for enriching the soil.

III. EIMCOBELT FILTER

The EimcoBelt filter has a diameter of 10 feet and a 12 foot face resulting in a total surface area of 377 square feet. The unit is equipped with a multiple roll EimcoBelt mechanism assembly designed for cloth filter media.

The filter valve is bridged to separate form and dry vacuum. A vacuum regulator placed between the vacuum source and the form receiver control form vacuum. No vacuum regulation was imposed on the dry vacuum and this vacuum level was allowed to operate at the highest level possible.

Pictures of the EimcoBelt filter installed in the Westfield Factory are shown by Figure 1 and Figure 2. The even cake formation on the EimcoBelt filter is shown by Figure 1, and this figure also shows the back side of the EimcoBelt. The front of the EimcoBelt, showing the cake discharge, is shown by Figure 2. It is noticed from Figure 2 that the filter cake discharges evenly and even tends to "slide-off" the filter media.

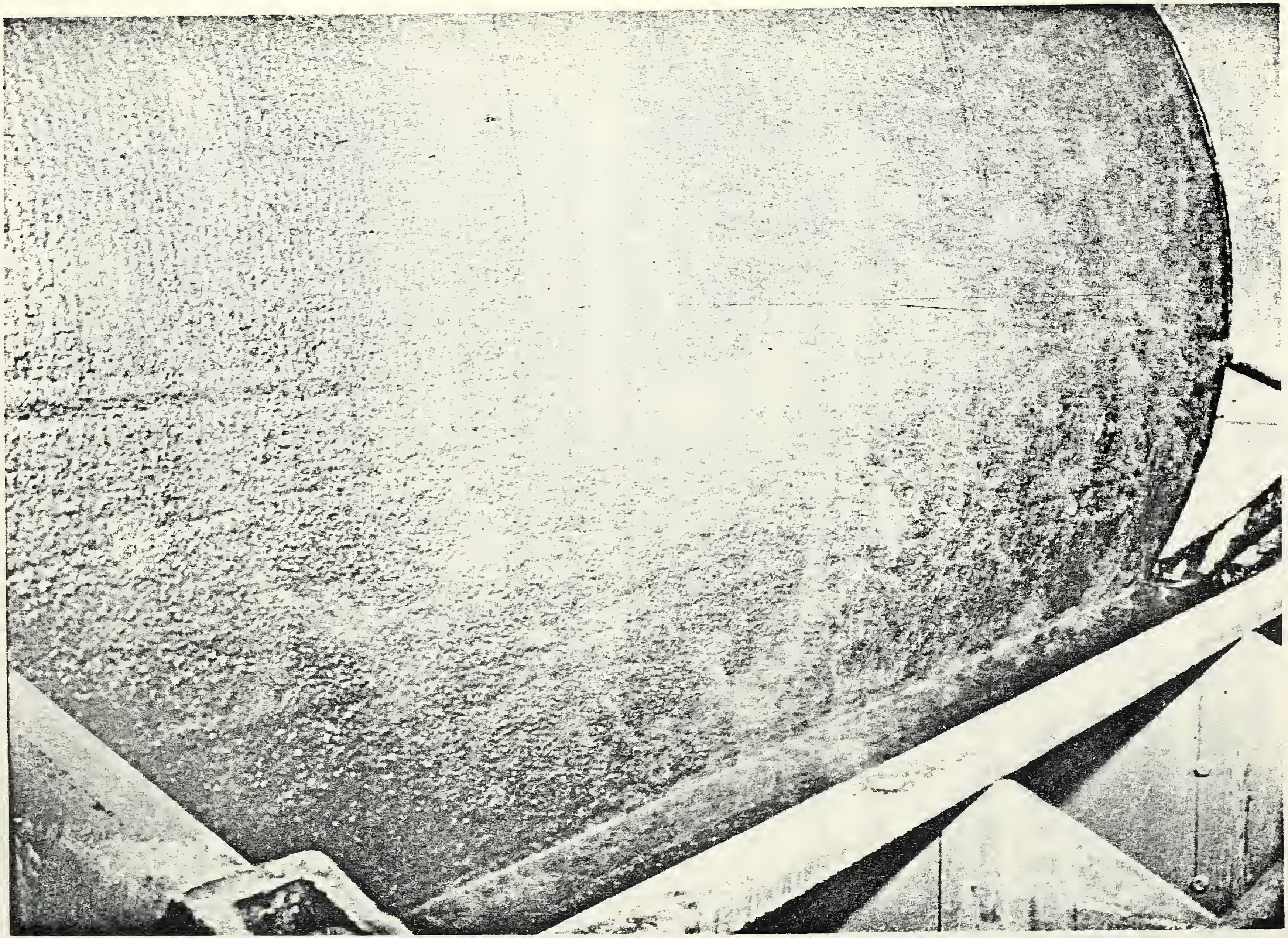


FIGURE 1

EVEN CAKE FORMATION ON 10' DIAMETER X 12' FACE EIMCOBELT

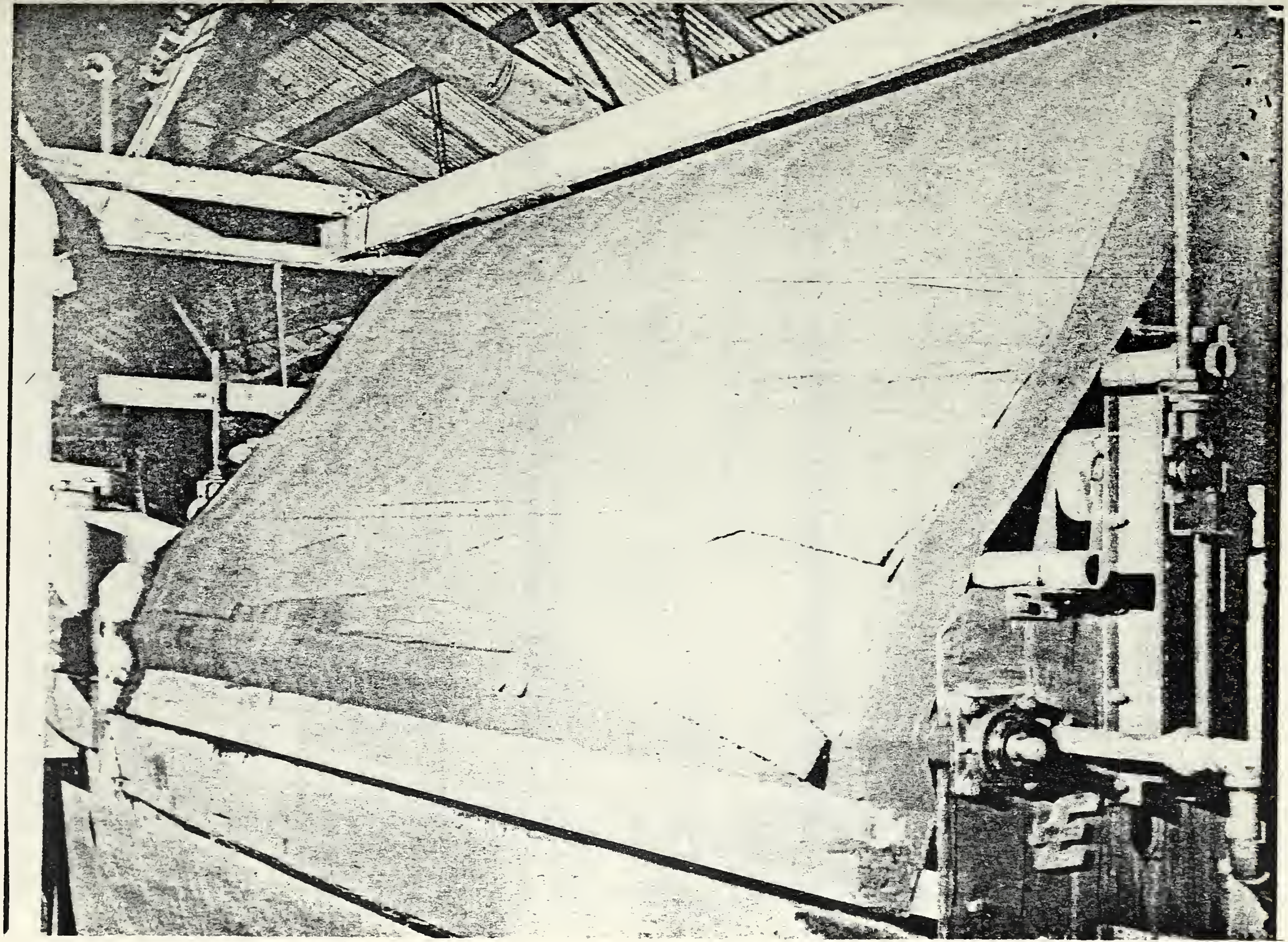


FIGURE 2

ILLUSTRATION OF COMPLETE CAKE DISCHARGE ON EIMCOBELT

IV. SCOPE OF INVESTIGATIONS

This chapter indicates the scope of investigations designed to evaluate the Westfield Factory mill juice clarification system. Testing procedures were as follows:

1. Clarified Streams. Three clarified streams existed, and they were:
    - a. EimcoBelt filtrate
    - b. Mill juice clarifier overflow
    - c. Filtrate clarifier overflow.

The above streams were analyzed for or had calculated:

- a. Brix
- b. Percent sucrose
- c. Purity
- d. pH
- e. Flow rate on only the EimcoBelt filtrate and filtrate clarifier overflow
- f. Temperature
- g. Suspended solids by volume.

2. Filter Cake. Three filters were in operation, and the wet filter cakes were analyzed for:
    - a. Rate of wet cake per four square feet of filtration area
    - b. Percent sucrose in wet cake
    - c. Percent water in wet cake
    - d. Cake thickness
3. Filter Feed. Feed to the filters consisted of several streams:
    - a. Mill juice clarifier underflow

b. Filtrate clarifier underflow

c. Overflow streams from all three filters

d. Milk of lime to assist filtration

e. Bagacillo.

The filter feed was measured for:

a. Percent suspended solids by volume

b. Temperature

c. Rate of lime addition.

4. Filters. Various information was collected on each of the three filters, and this included:

a. Total hours of operation

b. Drum speed
   (1) Total
   (2) Form

c. Number of cake wash headers on and rate of wash

d. Wash water pressure

e. Agitator speed

f. Vacuum
   (1) Form
   (2) Dry

g. Cake repulp water on the standard filters

h. EimcoBelt mechanism wash water
   (1) Rate
   (2) Temperature
   (3) Pressure

5. Laboratory Filtration Tests. The following were determined by laboratory filtration tests:

a. Comparison between field and laboratory filtration rates.

b. Effect of slurry temperature

c. Effect of form vacuum

d. Effect of various filter media
    (1) Rate of filtrate
    (2) Filtrate suspended solids

e. Effect of form time.

The discussion to follow, Chapter V - Results of Investigations, is based on information obtained by the above outlined scope of investigations. However, because of the voluminous paper which would result if all information obtained and correlated were recorded in this paper, only part of the results of investigation shall be reviewed under Chapter V. It is hoped that readers of this paper who are interested in aspects of the investigations not recorded by the paper shall seek the desired knowledge from the authors.

V. RESULTS OF INVESTIGATIONS

The results of investigations are based solely, unless otherwise specified, on operation at the Westfield Factory.

Recalling the Westfield Factory Flow Sheet - Illustration 1, it is noted that the underflow from the filtrate clarifier was blended in with various other streams. The means that the EimcoBelt always participated in the recirculation of solids which were the result of the standard filters and not solids which were present in the EimcoBelt filtrate. This method of operation is very important, and readers are asked to consider that the Westfield flow sheet does not represent operation which would be anticipated if only EimcoBelts were employed for mud filtration.

1. Filter Operating Time - Grinding originated on October 17, 1959, and filtration of cane mud also started on October 17. Due to a delay in

completing the process piping of the EimcoBelt filter, this filter did not start operation until the sixth crop date or October 22.

The total cumulative hours for all three filters during the 45-day campaign are shown by Graph 1, "Total Hours of Filter Operation." Graph 1 indicates that the EimcoBelt is capable of continuous operation on the filtration of cane muds. Despite preliminary modifications to the EimcoBelt and initial testing of filter cloths, the total operating hours of the EimcoBelt (739 hours) exceeded the total operating hours of standard filter B (663 hours).

A comparison of operating hours is shown by Table 1.

TABLE 1

COMPARISON OF FILTER OPERATING HOURS

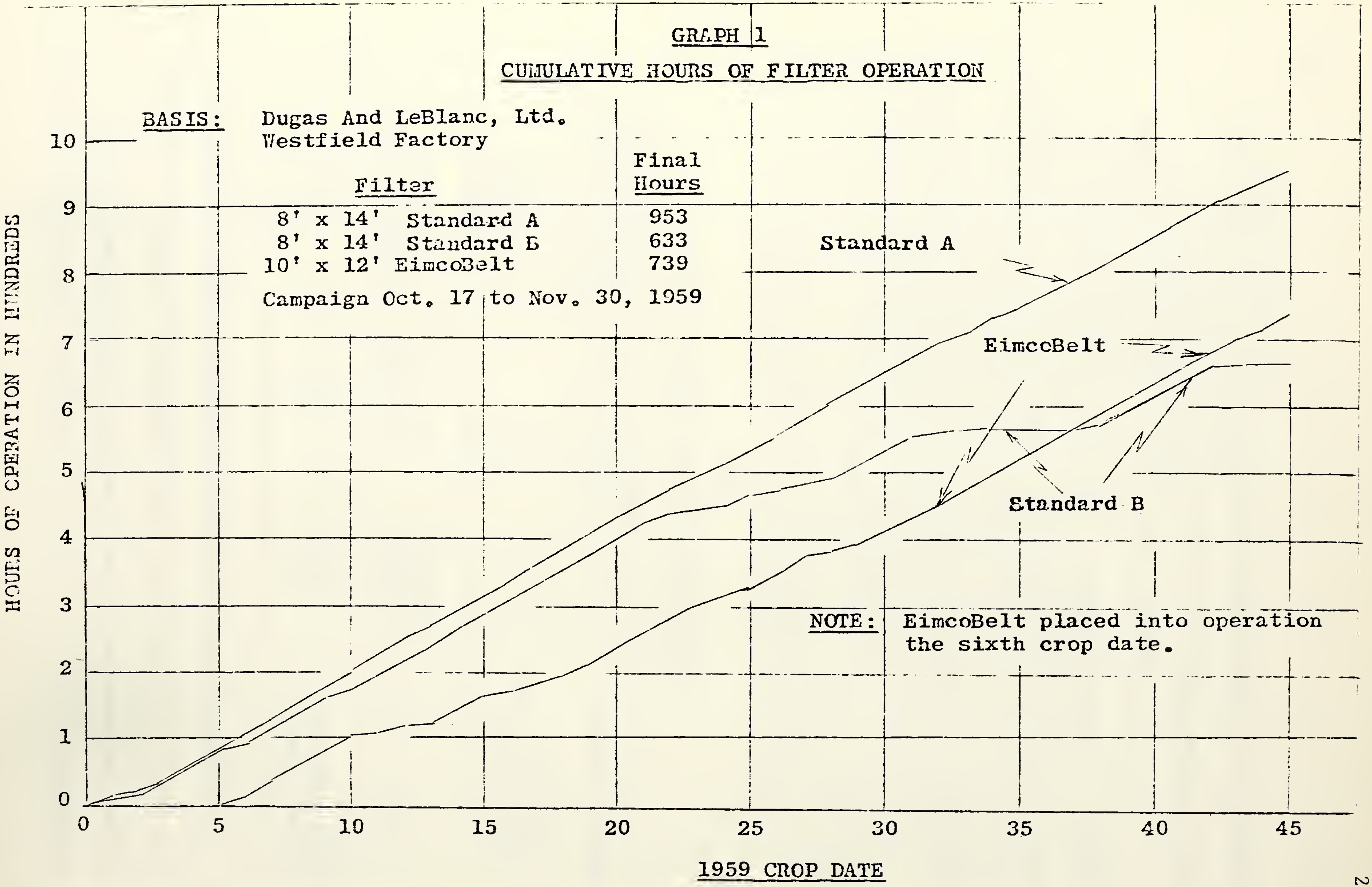
Number of Filters	Operating Hours	Percent of Total Operating Hours
One Filter	77	7.7
Two Filters	488	48.9
Three Filters	434	43.4
	999	100.0

Filter	Operating Hours	No. of Days Operating	% of Total Operating Hours
EimcoBelt	739	40	74.1
Standard Filter A	953	45	95.5
Standard Filter B	663	39	66.4

In summary, the EimcoBelt indicated, despite being the first filter ever applied to this application, that it is capable of continuous operation and need not be considered as an experimental unit by the cane sugar industry.

GRAPH 1

CUMULATIVE HOURS OF FILTER OPERATION



BASIS: Dugas And LeBlanc, Ltd.
Westfield Factory

Filter	Final Hours
8' x 14' Standard A	953
8' x 14' Standard B	633
10' x 12' EimcoBelt	739

Campaign Oct. 17 to Nov. 30, 1959

NOTE: EimcoBelt placed into operation the sixth crop date.

To further illustrate the continuous operation obtainable with the EimcoBelt, Table 2 is employed which shows the hours of filter operation during the last 17 crop days (38% of the 1959 campaign).

TABLE 2

FILTER OPERATING HOURS DURING THE LAST 17 CROP DAYS

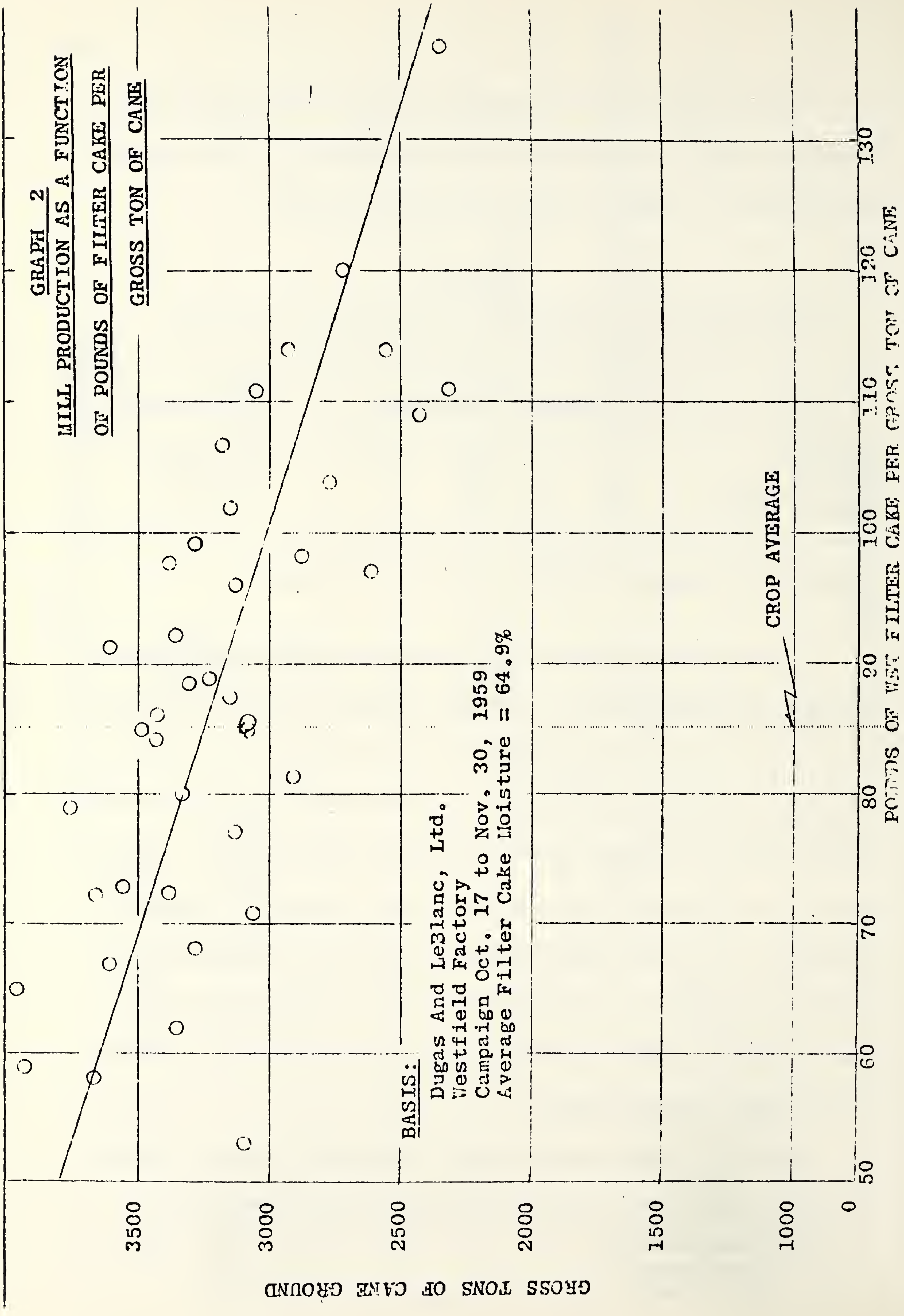
Filter	Hours of Operation	% of Total Hours
EimcoBelt	358	93.0
Standard Filter A	349	90.6
Standard Filter B	172	44.7

TOTAL FILTER OPERATING HOURS = 385 (for last 17 days).

2. Gross Tons of Cane Ground Compared to the Pounds of Wet Filter Cake Per Gross Ton of Cane. - As shown by Graph 2, a correlation shown by the "least squares" line apparently exists between the gross tons of cane ground and the ratio of pounds of wet filter cake to gross tons of cane ground. Graph 2 indicates that the permissible plant capacity is a function, among other variables, of the capacity of factory equipment to remove the settleable solids present after the cane juice has been heated and limed. If sufficient capacity is not available to remove the settleable matter, then the mill must either slow down or the excess matter may be disposed of by dumping clarifier bottoms.

Again, the results shown by Graph 2 should be reviewed critically for the gross tons of cane ground may have also been affected by:

a. Shortage of cane
b. Mill stoppage
c. Other factors.



GRAPH 2

MILL PRODUCTION AS A FUNCTION OF POUNDS OF FILTER CAKE PER GROSS TON OF CANE

BASIS:

Dugas And LeBlanc, Ltd.
Westfield Factory
Campaign Oct. 17 to Nov. 30, 1959
Average Filter Cake Moisture = 64.9%

However, there still appears to be justification in indicating (1) that if the settleable matter per gross ton of cane increases, the permissible grinding rate shall decrease, and (2) if sufficient equipment is not available to remove the settleable matter, then the rate of permissible production shall decrease at a greater rate. Ideally, if enough standby equipment were available, then the gross ton of cane ground would be relatively constant regardless of the amount of "mud" per gross ton of cane.

3. Percent Suspended Solids, by Volume, in Various Process Streams.- In discussing the clarity of various process streams, a brief review is warranted on the importance of process stream clarity.

One of the most recent advancements in the growing technology of various process industries is to streamline plant processing and to boost up plant capacity by the elimination of process streams that are being recirculated. In industries where the recirculation of process streams does not result in operational advantages, the results of investigations have been to eliminate these recirculating streams. Investigations in processing fields such as coal, pulp and paper, corn gluten, etc. have indicated significant economical savings when the process streams are not unnecessarily recirculated.

In addition, many industries that recirculate process streams as a means of water conservation have found it advantageous to remove any fines from the recirculated flow. The recirculation of fines often results in a "build-up" of fines in the process, and if these fines are not removed as fast as they enter a system, difficulties in operating results usually follow. Coal processing is an industrial operation where the removal of fines from recirculating process wash water streams has been found to be very advantageous.

In the cane sugar industry, a significant recirculating stream which apparently serves no operational or economical advantage is the recirculation of filtrate from the standard filters.

Underflow from the mill juice clarifiers contains valuable sucrose which is recoverable by separating the solids from the liquid by filtration and washing of the filter cake to displace the juice in the filter cake. Either pressure or vacuum filtration may be employed.

If pressure filtration is used, a cotton duck filter media is employed. which produces a suspended solids free filtrate. However, the plate and frame presses have the following disadvantages:

a. High media cost for both replacement and cleaning of used cloths

b. High labor cost to empty and start the presses

c. Low cake washing efficiencies

d. High floor space requirements

e. Batch operation.

The above disadvantages are usually great enough to offset the advantages of a clear filtrate and low capital investment costs. To eliminate the disadvantages of the plate and frame filters, the use of continuous vacuum drum filters was introduced in the 1930's and had the following advantages over the plate and frame filters:

a. Continuous operation

b. Lower labor costs

c. Lower floor space requirements

d. Improved cake washing efficiencies.

These improvements were considered as an economical substitute for a dirty filtrate and greater original equipment cost.

A porous filter media (a copper or stainless steel perforated screen) had to be employed on the continuous vacuum filters because of media blinding. Removal of fines with this type of filter was based on the retention of the coarse filter aid particles (bagacillo) on the perforated screen and the retention of the fine particles on this mat of filter aid. If the retention of the fine particles was not sufficient, then a build-up of the fines would result through recirculation of the filtrate stream.

A dirty filtrate requires:

a. Additional clarification capacity to resettle the fines

b. Facilities for reheating and possibly reliming the filtrate prior to resedimentation.

Both of the above factors necessitated initial capital outlay and continuous operating costs. Clarification capacity requirements were not proportional to the capacity required for the mill juice but are somewhat higher as the filtrate has a higher fraction of fines in comparison with the mill juice and therefore settle slower than the treated mill juice.

The need therefore arose in the cane sugar industry for a process which would increase plant capacity and efficiency by eliminating the recirculation of any unnecessary process streams.

The specific requirements were for a filter which would have all of the advantages of a standard drum filter, none of the disadvantages of batch pressure filters, and still produce a clear filtrate.

The EimcoBelt continuous vacuum filter was designed to accomplish the stipulations cited in the last paragraph.

As clarity is one of the most important criteria, it shall be reviewed in detail.

A. Mill Juice Prior to Liming and Heating. - The average of 64 tests taken during the 1959 crop indicated an arithmetic average of 3.5 ± 0.1 percent suspended solids by volume. A maximum value of 10.0 was obtained and a minimum value of 1.8. The arithmetic mean suspended solids value was 3.0 percent.

B. Clarified Streams - Clarified streams are defined as those going directly to the evaporators.

A comparison of solids content in clarified streams is shown by Table 3.

TABLE 3.

COMPARISON OF SUSPENDED SOLIDS, BY VOLUME, IN CLARIFIED STREAMS

Clarified Stream	No. of Tests	No. of Testing Days	Arithmetic Average (1)	Max. Value	Min. Value	Arithmetic Mean
EimcoBelt filtrate	75	36	0.10 ± .02	0.20	.05	0.10
Mill juice clarifier overflow	149	36	0.07 ± .02	0.25	.05	0.05
Filtrate clarifier overflow	54	29	0.13 ± .02	1.5	.05	0.10

(1) In calculating the arithmetic average, values less than 0.05 percent suspended solids, by volume, were assumed to be equal to 0.05. The results of Table 3 indicate that the clarity of the EimcoBelt filtrate is equivalent to the filtrate clarifier overflow and is approximately equal to the mill juice clarifier overflow. The variance between the mean of the EimcoBelt and the mill juice clarifier is felt to be insignificant. Clarities of 0.10 percent suspended solids were considered acceptable by cane sugar mill supervisors. The maximum and minimum values for the clarified streams indicated more stable operation with the EimcoBelt (maximum s.s. of 0.20) than the mill juice clarifier (maximum s.s. of 0.25) and in particular the filtrate clarifier (maximum s.s. of 1.5).

The results indicate that under adverse operating conditions, the EimcoBelt operates more reliably than the mill juice clarifier or the filtrate clarifier. Only 1.3 percent of all values were greater than 0.20 percent suspended solids, by volume, for the EimcoBelt, whereas 3.3 percent of all values were greater than 0.20 for the mill juice clarifier, and 11.2 percent of all values greater than 0.20 for the filtrate clarifier.

The importance of operating stability cannot be over-emphasized for consistant efficient plant operation is dependent upon plant stability.

C. Clarifier Underflow Streams - Underflow streams were from the three mill juice clarifiers and one filtrate clarifier. Underflow streams from both types of clarifiers indicate averages of 70 percent, by volume, suspended solids. However, there was greater dispersion of underflow concentrations from the filtrate clarifier than from the mill juice clarifier. This dispersion of data is to be anticipated due to the variation under which the filtrate clarifier is operated. As an example, 4.3 percent of all values were below 60 percent suspended solids, by volume, for the mill juice clarifier underflow, whereas 24.9 percent of all values were below 60 percent for the filtrate clarifier underflow.

D. Filtrate From Standard Filters. - The results of 68 tests taken over a period of 33 days indicate an arithmetic average of 19 percent suspended solids, by volume, and an arithmetic mean of 18. The maximum value obtained was 40 and the minimum value was 3 percent. The degree of dispersion is shown by Graph 3 which indicates the cumulative percent of suspended solids values at various levels of suspended solids.

Ninety percent of all values grouped about the arithmetic mean ranged from approximately 6 to 38 percent suspended solids by volume.

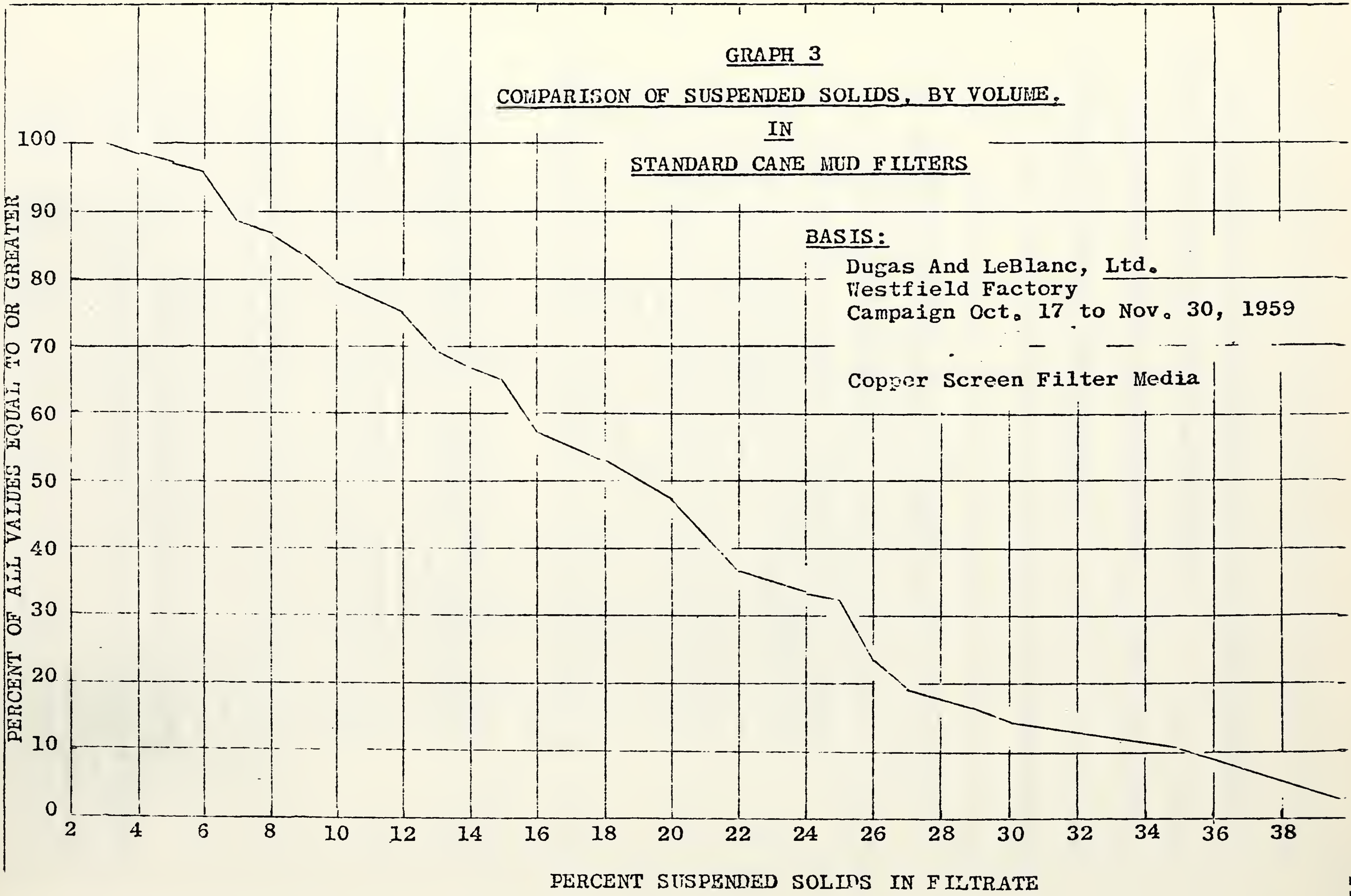
5. Comparison of Suspended Solids, by Volume, in Filtrate Streams.- A comparison of clarities for the EimcoBelt filtrate and the standard filters is noted by Graph 4.

GRAPH 3

COMPARISON OF SUSPENDED SOLIDS, BY VOLUME.

IN

STANDARD CANE MUD FILTERS



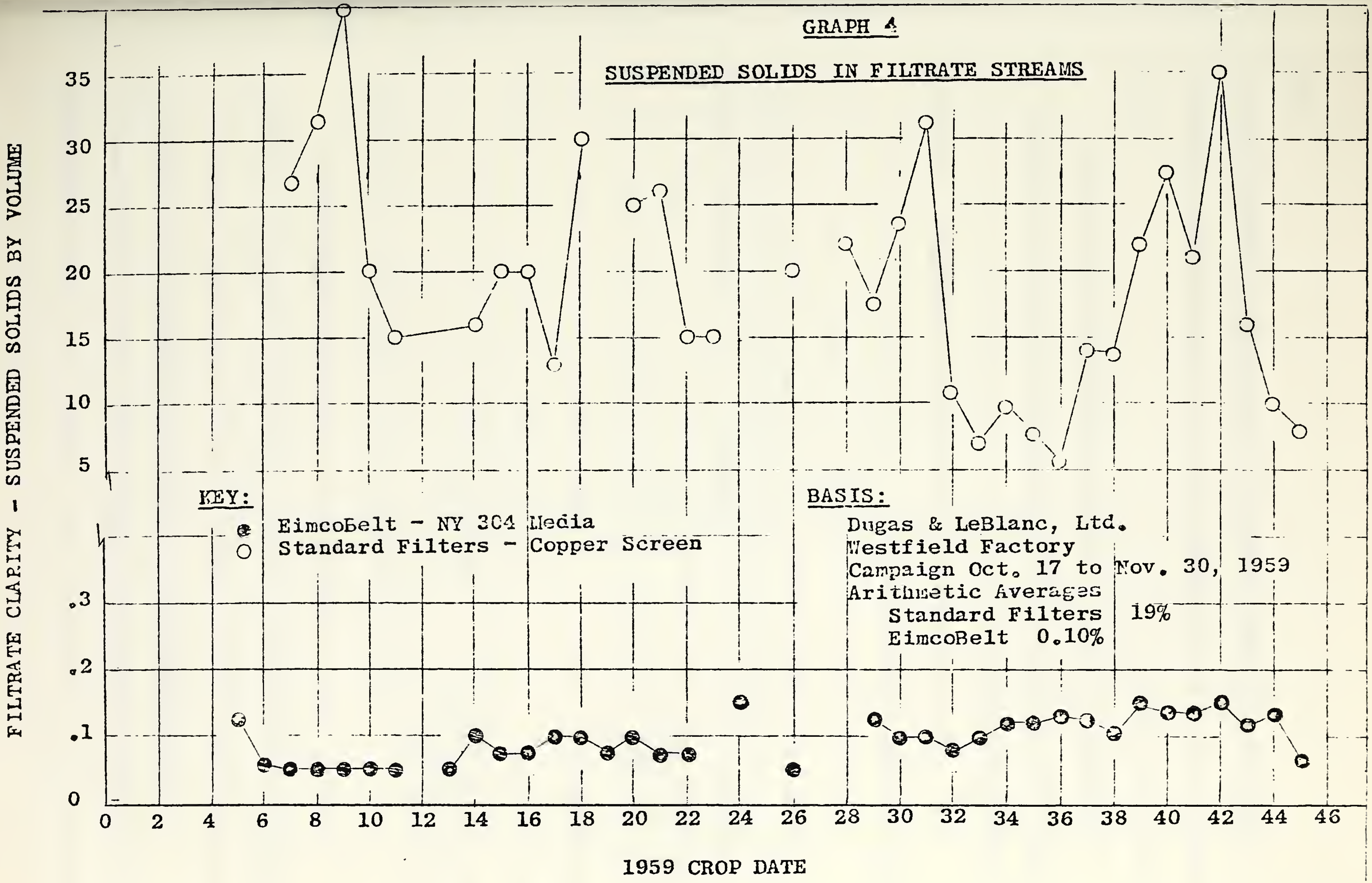
BASIS:

Dugas And LeBlanc, Ltd.
Westfield Factory
Campaign Oct. 17 to Nov. 30, 1959

Copper Screen Filter Media

GRAPH 4

SUSPENDED SOLIDS IN FILTRATE STREAMS



The suspended solids, by volume, content of the standards is noted to fluctuate rapidly and significantly while the EimcoBelt filtrate clarities are relatively constant.

Therefore the variables which cause the filtrate clarities of the standard filters to fluctuate exert no significant influence on the clarity of the EimcoBelt filtrate.

A more effective comparison of the difference between the two different filtrate streams is noted by Table 5.

TABLE 5

COMPARISON OF SUSPENDED SOLIDS, BY VOLUME, IN FILTRATE STREAMS

Comparison	EimcoBelt	Standard Filter
Arithmetic Average	0.10	19
Arithmetic Mean	0.10	18
Maximum Value	0.20	40
Minimum Value	Less than 0.05	3
Range of 90% of all values around the arithmetic mean	Less than 0.05 to 0.18	6 to 38

The EimcoBelt is more uniform in results than the standard filters and can be depended upon to produce a clear filtrate regardless of changes in variables which materially affect the clarity of the standard filtrate.

6. Suspended Solids in the Filtrate From Standard Filters Compared to the Pounds of Wet Filter Cake Per Gross Ton of Cane. - The fluctuating characteristics of the standard filtrate indicated that perhaps the fluctuation

could be correlated with other variables. One variable which indicated a correlation with filtrate clarity was pounds of wet filter cake per gross ton of cane.

The results of the correlation described above are shown by Graph 5. Assuming a linear arithmetic correlation over the testing range, a "least squares" line was developed which gives the minimum squared deviation of the data from the line.

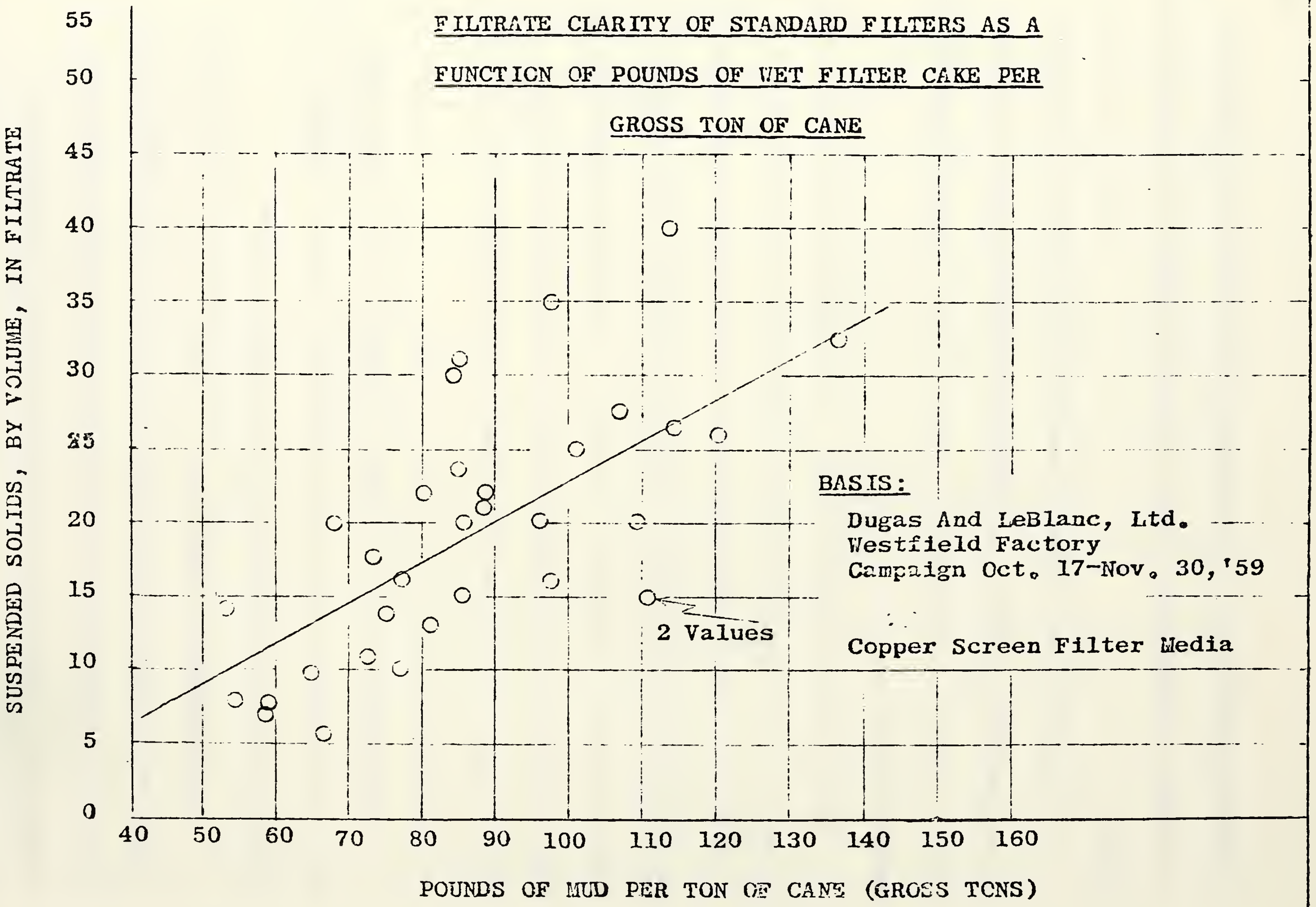
The indicated correlation shows that the weight of mud per gross ton of cane is one (and probably the most significant) of the factors which affects filtrate clarity. As mud conditions become poorer, the standard filtrate clarity becomes poorer. As an approximation, if the pounds of mud per gross ton of cane were increased 100 percent, the suspended solids by volume in the standard filtrate would increase 133 percent. Graph 5 helps to explain why mill upsets occur so rapidly after excessive mud loadings are imposed on a plant.

Data obtained on the EimcoBelt indicates that despite mud conditions, the EimcoBelt clarity never exceeded the maximum EimcoBelt filtrate value of 0.20 percent suspended solids by volume.

7. Miscellaneous Variables. - Cake moistures as well as percent sucrose in wet filter cake were equal for both the standard filters and the EimcoBelt. Moistures in filter cake averaged 65 percent and sucrose averaged 4.9%. The arithmetic average pH for the EimcoBelt filtrate was 6.3, for the mill juice clarifier overflow 6.0, and for the filtrate clarifier overflow 6.0.

GRAPH 5

FILTRATE CLARITY OF STANDARD FILTERS AS A FUNCTION OF POUNDS OF WET FILTER CAKE PER GROSS TON OF CANE



BASIS:

Dugas And LeBlanc, Ltd.
Westfield Factory
Campaign Oct. 17-Nov. 30, '59

Copper Screen Filter Media

The dry filter cake obtained with the EimcoBelt filter is attested to by Figures 3 and 4, which are photographs indicating the clean cake discharge obtained, and also the underside of the filter cake. Figure 4 indicates the structure of the filter media as noted by the impression of the filter media on the cake.

8. Purity of Clarified Streams. - The following streams were calculated for purity by employing Brix and sucrose data:

a. Mill juice clarifier overflow

b. Filtrate clarifier overflow

c. EimcoBelt filtrate.

The daily averaged results of purity are plotted on Graph 6. The following interpretation of Graph 6 may be made:

a. The purity of mill juice clarifier overflow is higher than the purity of either the EimcoBelt filtrate or filtrate clarifier overflow.

b. The EimcoBelt filtrate has higher purities than the filtrate clarifier overflow.

Purity is an acceptable indication of inversion (other methods such as glucose determinations would be more valid; however, these methods were not employed because of the unavailability of laboratory equipment).

Arithmetic averages for purities of the clarified streams are listed by Table 6.

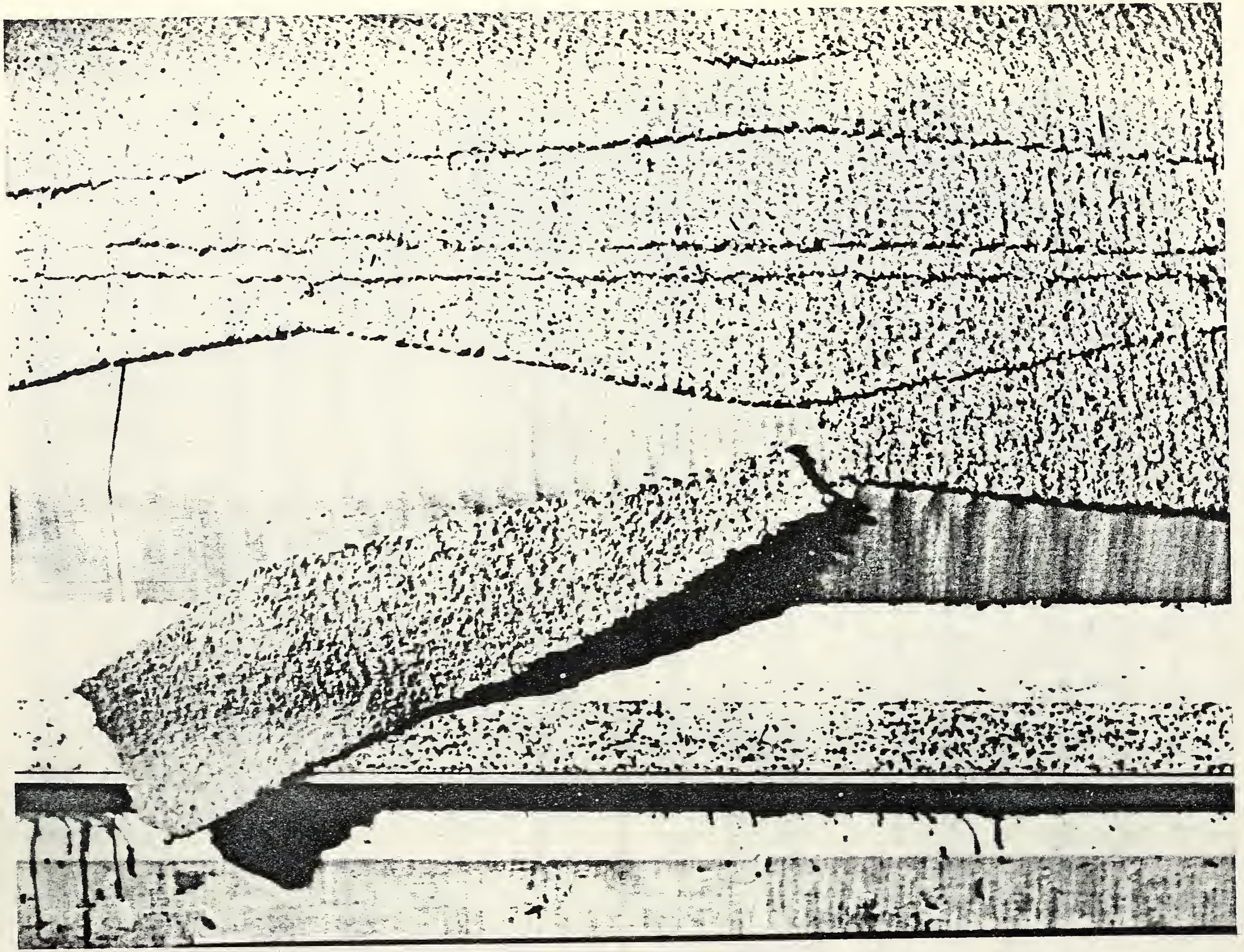


FIGURE 3

CLOSE-UP OF CAKE DISCHARGE ON 10' DIAMETER X 12' FACE EIMCOBELT

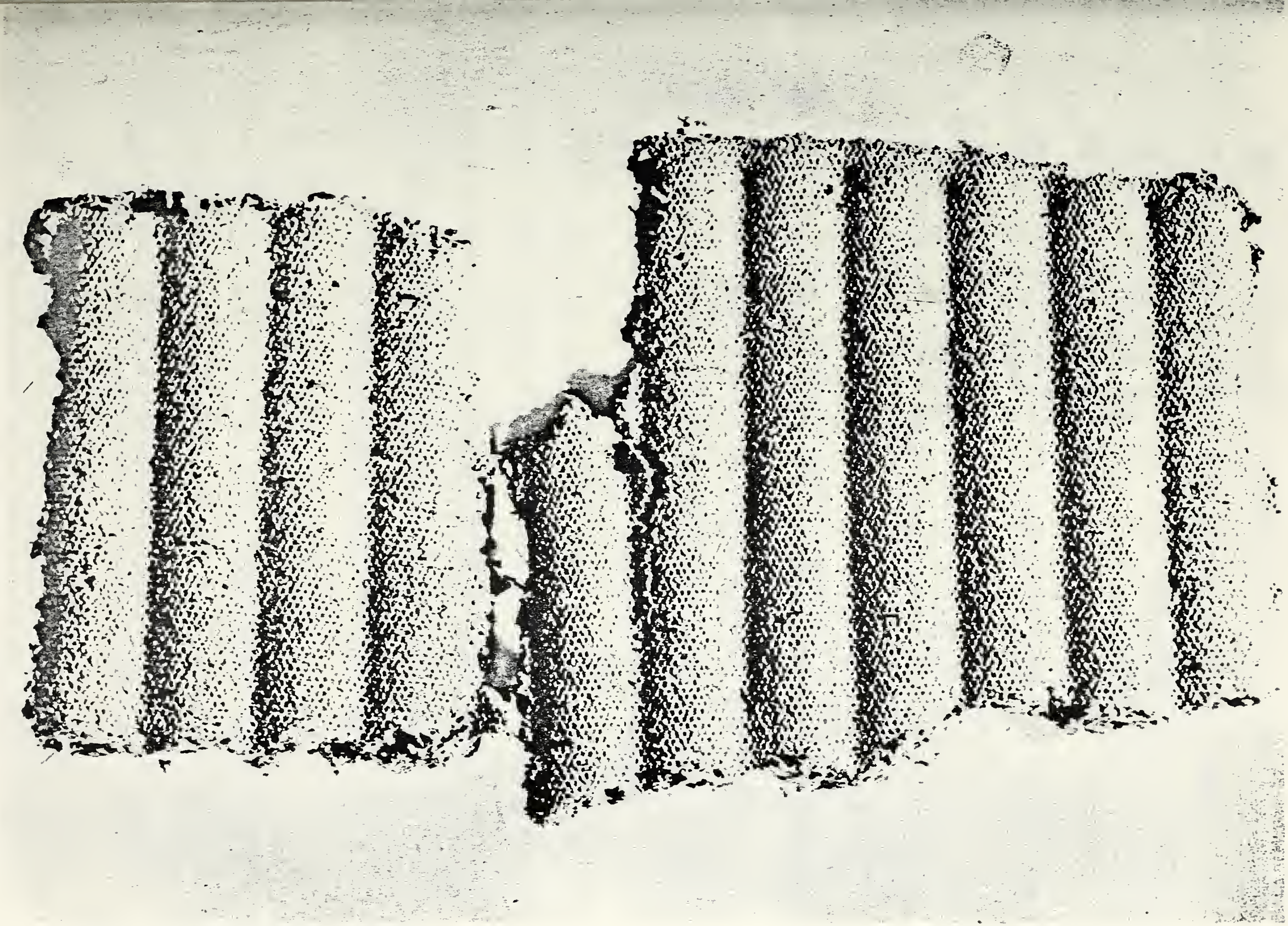
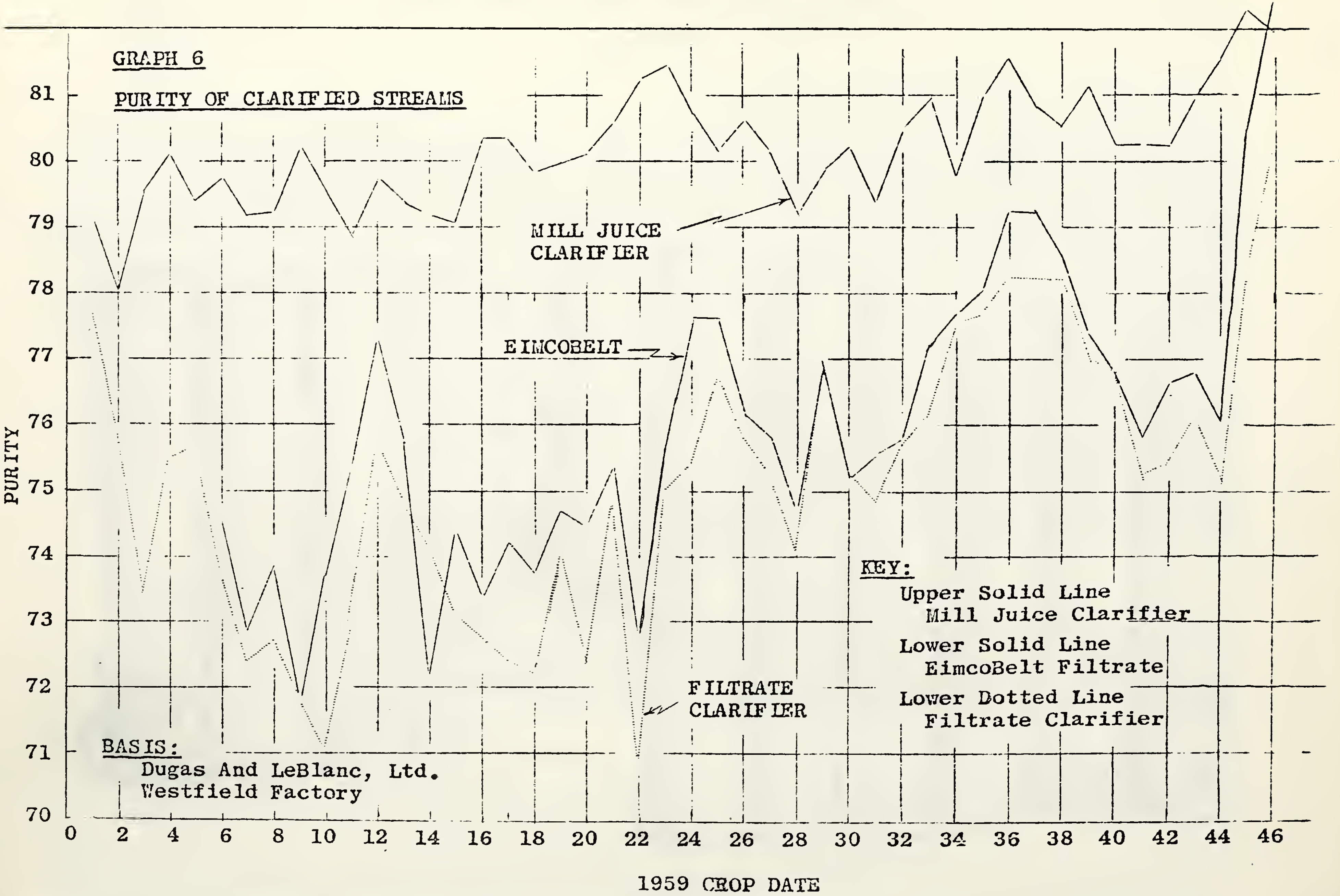


FIGURE 4

CLOTH SIDE OF FILTER CAKE FROM EIMCOBELT

GRAPH 6

PURITY OF CLARIFIED STREAMS



KEY:
Upper Solid Line
Mill Juice Clarifier
Lower Solid Line
EimcoBelt Filtrate
Lower Dotted Line
Filtrate Clarifier

BASIS:
Dugas And LeBlanc, Ltd.
Westfield Factory

TABLE 6

COMPARISON OF PURITY FOR CLARIFIED STREAMS

Clarified Stream	Arithmetic Average	Number of Tests
Mill Juice Clarifier Overflow	80.04	178
Filtrate Clarifier Overflow	75.03	157
EimcoBelt Filtrate	76.06	137

The results show that the filtrate clarifier has $\frac{76.06 - 75.03}{80.04 - 76.06} \times 100 = 26$ per cent greater drop in purity when compared with the drop in purity between the EimcoBelt filtrate and the mill juice clarifier overflow.

Additional increases in purity could be obtained if the EimcoBelt were not penalized by the recirculation of the standard filtrate streams. Referring to Illustration 1 at the beginning of this paper, it is noted that a portion of the feed to both the standard filters and EimcoBelt consists of the solids settled out in the filtrate clarifier. If the underflow solids from the mill juice clarifier were removed by a once through process, as is done with the EimcoBelt, the filtrate clarifier would not be necessary and inversion occurring in the filtrate clarifier would be eliminated.

Only one period of time was available when the EimcoBelt was operating on mill juice clarifier underflow - no recirculation of solids from the filtrate clarifier, and Table 7 indicates comparative results.

TABLE 7

COMPARISON OF CLARIFIED STREAM CHARACTERISTICS WITH ONLY THE EIMCOBELT OPERATING AND WITH BOTH THE STANDARD FILTERS AND EIMCOBELT OPERATING

Filters Operating	Stream	Purity
EimcoBelt and Standard Filters	Mill Juice Clarifier	80.47
	Filtrate Clarifier	76.03
	EimcoBelt Filtrate	76.99
EimcoBelt	Mill Juice Clarifier	81.42
	EimcoBelt	78.99

In summary, if only EimcoBelt filters were employed, the inversion in sucrose would be expected to be one-half of what the degree of inversion is with the standard filters-clarifier combination.

9. Drop in Clarified Stream Purity and Pounds of Wet Filter Cake Per Gross Ton of Cane. - Causes for drops in purity other than retention time, temperatures, and pH would be the percent of solids in the cane mill juice and also in the filtrate from the standard filters.

The drop in purity was measured as the drop in purity between the mill juice clarifier overflow and the filtrate clarifier overflow and this difference is shown plotted on Graph 7A as a function of pounds of wet filter cake per ton of cane.

A correlation is indicated by the least squares line and is based on the assumption that a linear correlation exists over the range of test data.

The correlation developed indicates that the drop in purity is partly a function of the pounds of wet filter cake per gross ton of cane.

As the standard filtrate was also indicated to be a function of the pounds of mud per ton of cane it would be anticipated that if the solids in the filtrate were increased, the drop in purity between the two clarifier overflow streams would increase.

The difference between mill juice clarifier overflow purity and EimcoBelt filtrate purity as a function of pounds of wet filter cake per ton of cane is plotted on Graph 7B. A correlation, based on a least squares line, is indicated on Graph 7B, and it is noted that the correlation is identical in the rate of increase in purity drop as the pounds of wet filter cake per gross ton of cane is increased. However, the absolute value of purity drop is minimized when the EimcoBelt is employed. A comparison of purity drop for the EimcoBelt filter and the combination standard filters - clarifier is shown on Graph 7C.

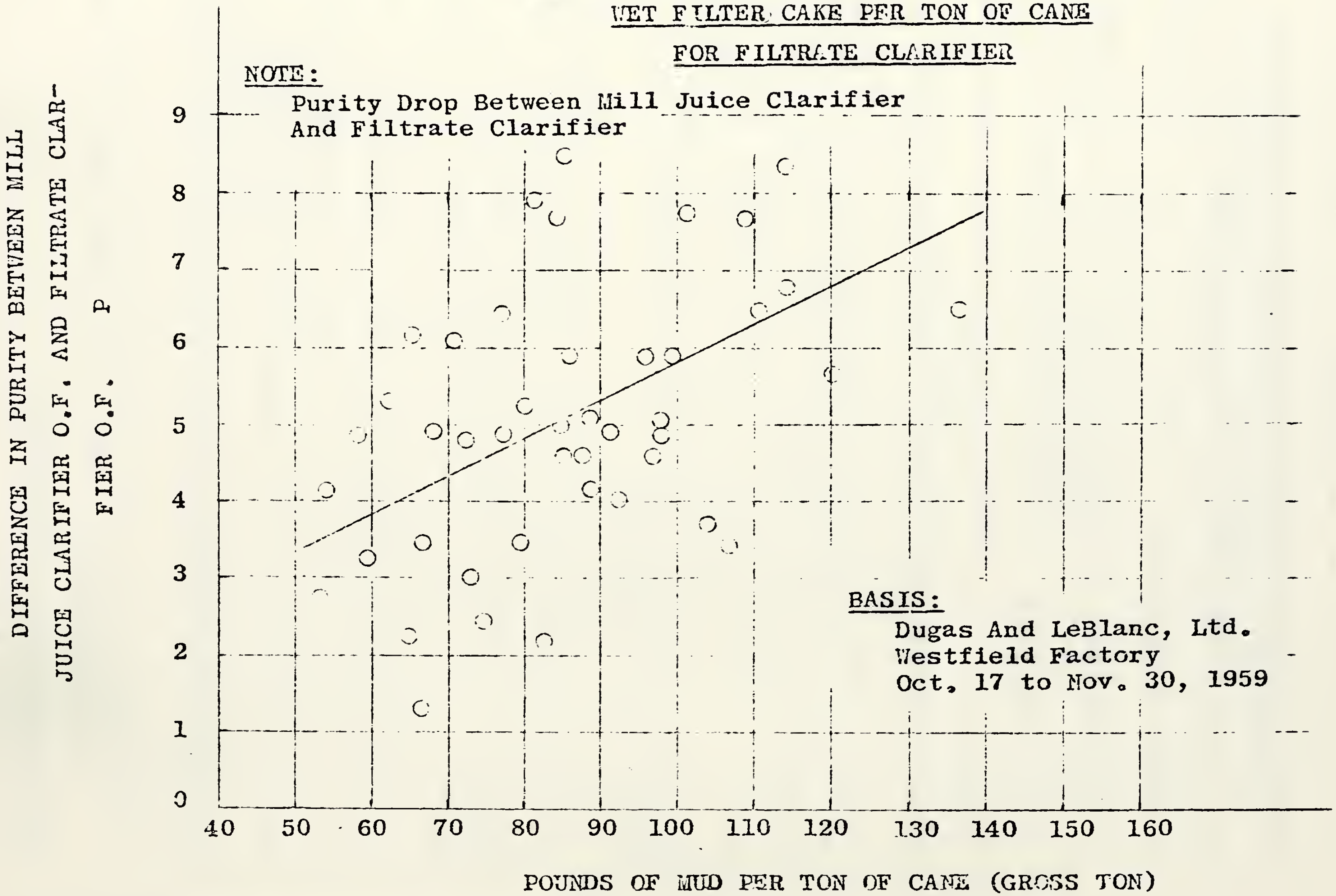
Graph 7C has the least squares line drawn for the EimcoBelt filtrate and the filtrate clarifier overflow. A similarity in correlations for the two parameters exists. As the solids concentration increases (as measured by the pounds of filter cake per gross ton of cane), the drop in purity becomes greater. However, the drop in purity is less for the EimcoBelt filtrate. Even lower purity drops would be anticipated for the EimcoBelt if the EimcoBelt did not participate in the recirculation of the filtrate clarifier underflow.

10. Filtration Rates. - There are two streams which must be considered in discussing filtration Rates:

a. Rate of Filtrate
b. Rate of Filter Cake.

GRAPH 7A

DROP IN PURITY AS A FUNCTION OF POUNDS OF WET FILTER CAKE PER TON OF CANE FOR FILTRATE CLARIFIER

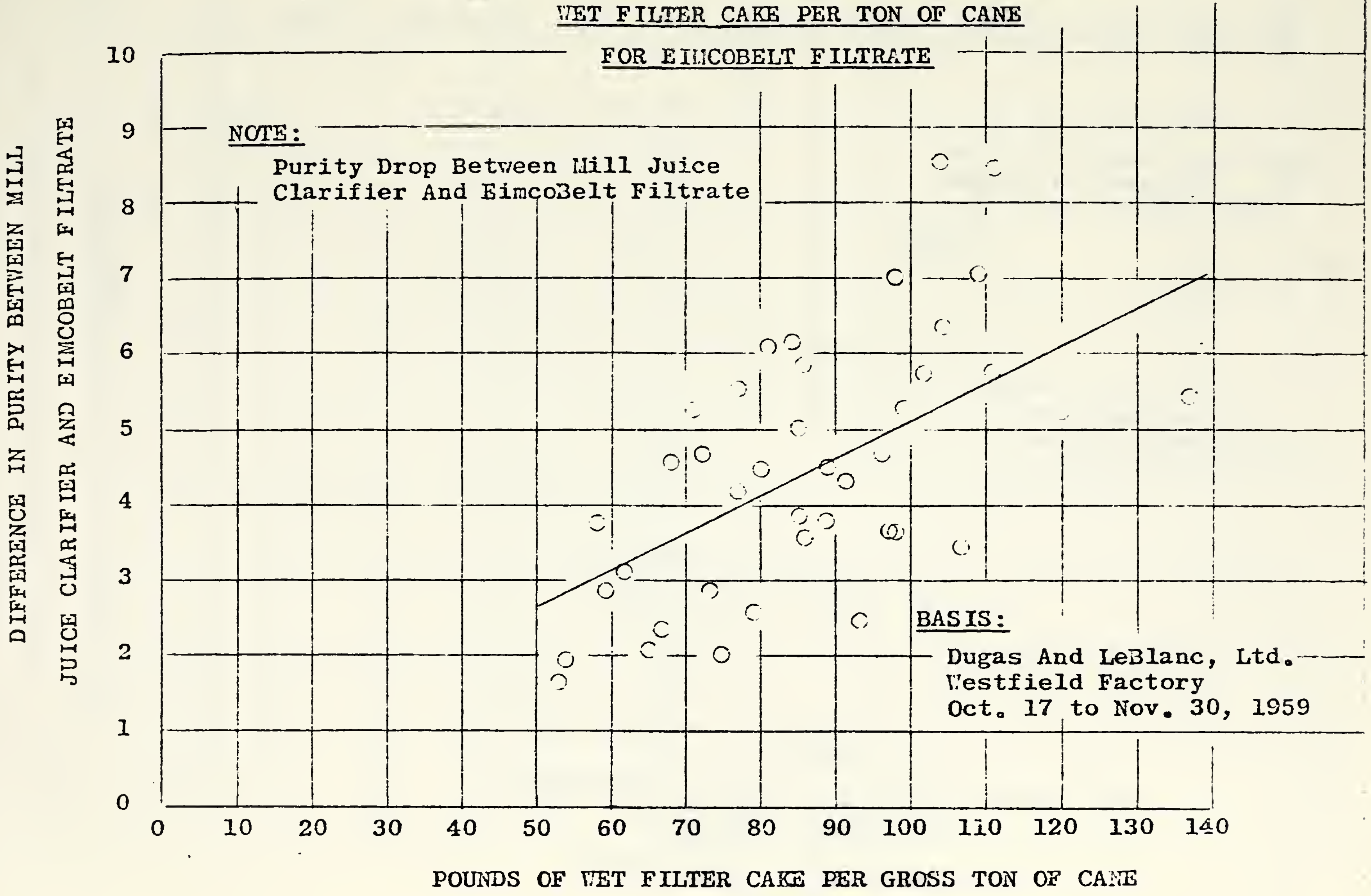


NOTE:
Purity Drop Between Mill Juice Clarifier
And Filtrate Clarifier

BASIS:
Dugas And LeBlanc, Ltd.
Westfield Factory
Oct, 17 to Nov. 30, 1959

GRAPH 7B

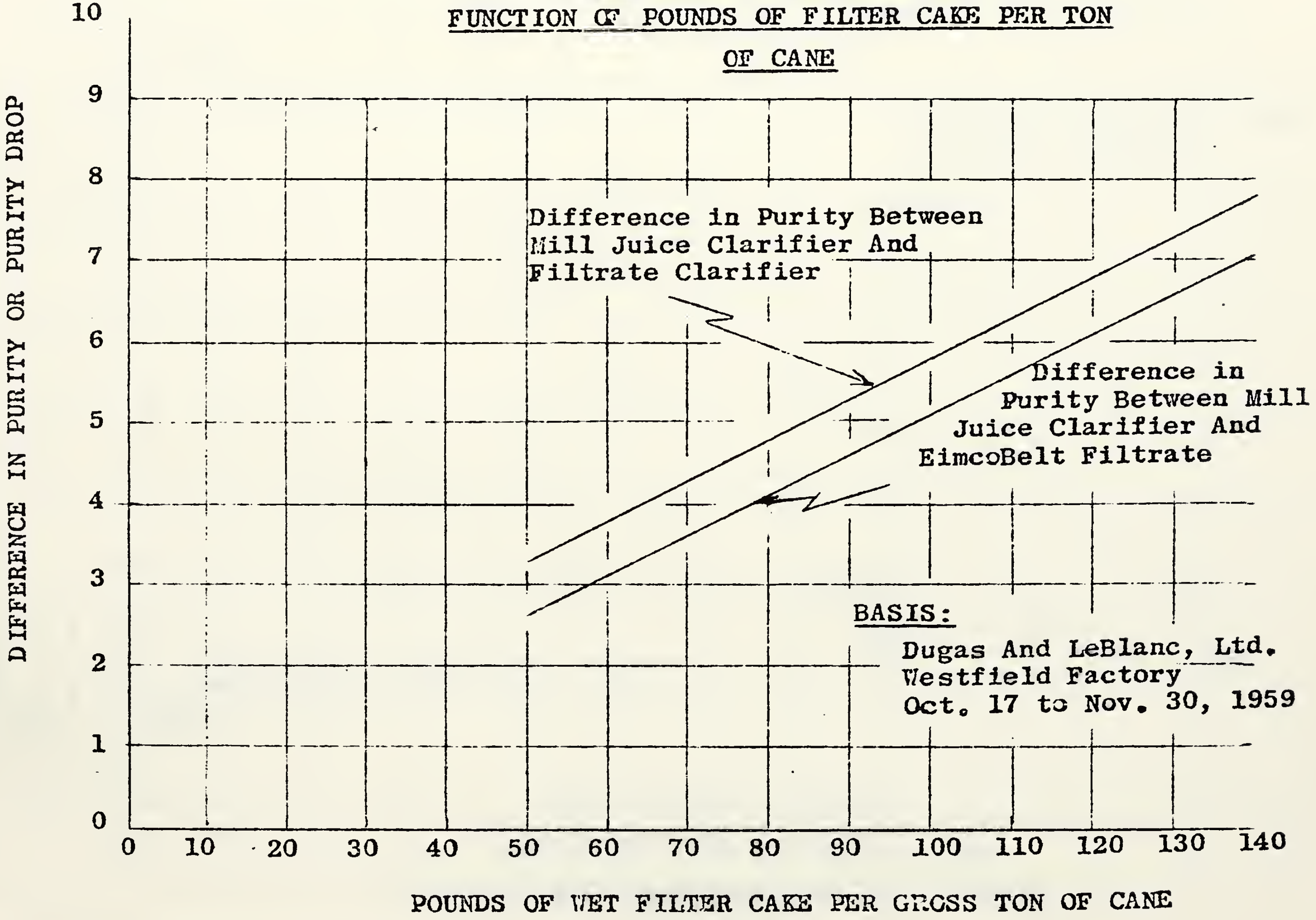
DROP IN PURITY AS A FUNCTION OF POUNDS OF WET FILTER CAKE PER TON OF CANE FOR EIMCOBELT FILTRATE



NOTE:
Purity Drop Between Mill Juice
Clarifier And EimcoBelt Filtrate

BASIS:
Dugas And LeBlanc, Ltd.
Westfield Factory
Oct. 17 to Nov. 30, 1959

GRAPH 7C
COMPARISON OF PURITY DROPS OF CLARIFIED STREAMS AS A FUNCTION OF POUNDS OF FILTER CAKE PER TON OF CANE



BASIS:
Dugas And LeBlanc, Ltd.
Westfield Factory
Oct. 17 to Nov. 30, 1959

In determining filtration rates, the process flow sheet employed at Westfield must again be reviewed. The feed to all three filters consisted of:

- a. Clarifier underflow
  - (1) Mill Juice clarifier
  - (2) Filtrate clarifier
- b. Bagacillo
- c. Lime
- d. Overflow streams from all three filters.

Therefore the EimcoBelt filter had to partake in the bad effects of solids recirculation caused by the standard filters, and these recirculated solids consisted mainly of fines. In summary, the following conditions existed at Westfield:

- a. The EimcoBelt filter had a greater proportion of fines in the feed to the filter, as a result of fines being recirculated by the standard filters, than would have existed if the EimcoBelt filtered mud coming directly from the mill juice clarifier.
- b. The standard filters had a lower concentration of fines in the feed than would have been encountered if an EimcoBelt filter was not employed. This lower concentration of fines is due to the EimcoBelt not recirculating any fines but removing all sizes of suspended particles.

Again, the system installed at Westfield benefited the standard filters and imposed a penalty on the EimcoBelt.

A comparison of filtration rates would be to employ the ratio of wet filter cake produced per gallon of clear juice produced. Naturally, for the standard filters the clear juice produced would have to be the overflow from the filtrate clarifier.

From the EimcoBelt the crop average was 6.66 pounds of wet filter cake per gallon of clear juice, and for the standard filters the crop average was 12.12 pounds of wet filter cake per gallon of clear juice. Although the data indicates that the standard filters remove more suspended solids per gallon of clear liquid than the EimcoBelt filter, Illustration 2 is employed to indicate why this exists. For illustration purposes, both filtration rates are based on one gallon of clear liquid per square foot of filtration area.

From Illustration 2, it is indicated how the standard filters can appear to be "removing" more mud when actually the standard filters are simply screening out the coarse particles (mostly bagacillo) from a large glow of feed. Also, the illustration shows the situation which exists when an EimcoBelt and standard filters are compared where the filtrate clarifier underflow is blended in with the feed to the EimcoBelt.

VI. ECONOMICS OF EIMCOBELT FILTER

For this type of installation, a proper comparison would not be between an EimcoBelt filter and a standard filter but between an EimcoBelt filter and a combination of a standard filter and clarification capacity for the standard filtrate.

There are two viewpoints to consider in the disposal of sugar cane mud. One is that the filtration step is to recover the juice associated with the mud and the other is to get rid of the mud. Although the viewpoints appear identical, they differ for one is interested in the rate of clear juice while the other is interested in the rate of filter cake. In a previous discussion, the filtration rates for the two types of filters - the EimcoBelt and the standard filters - differed, and this is due to a

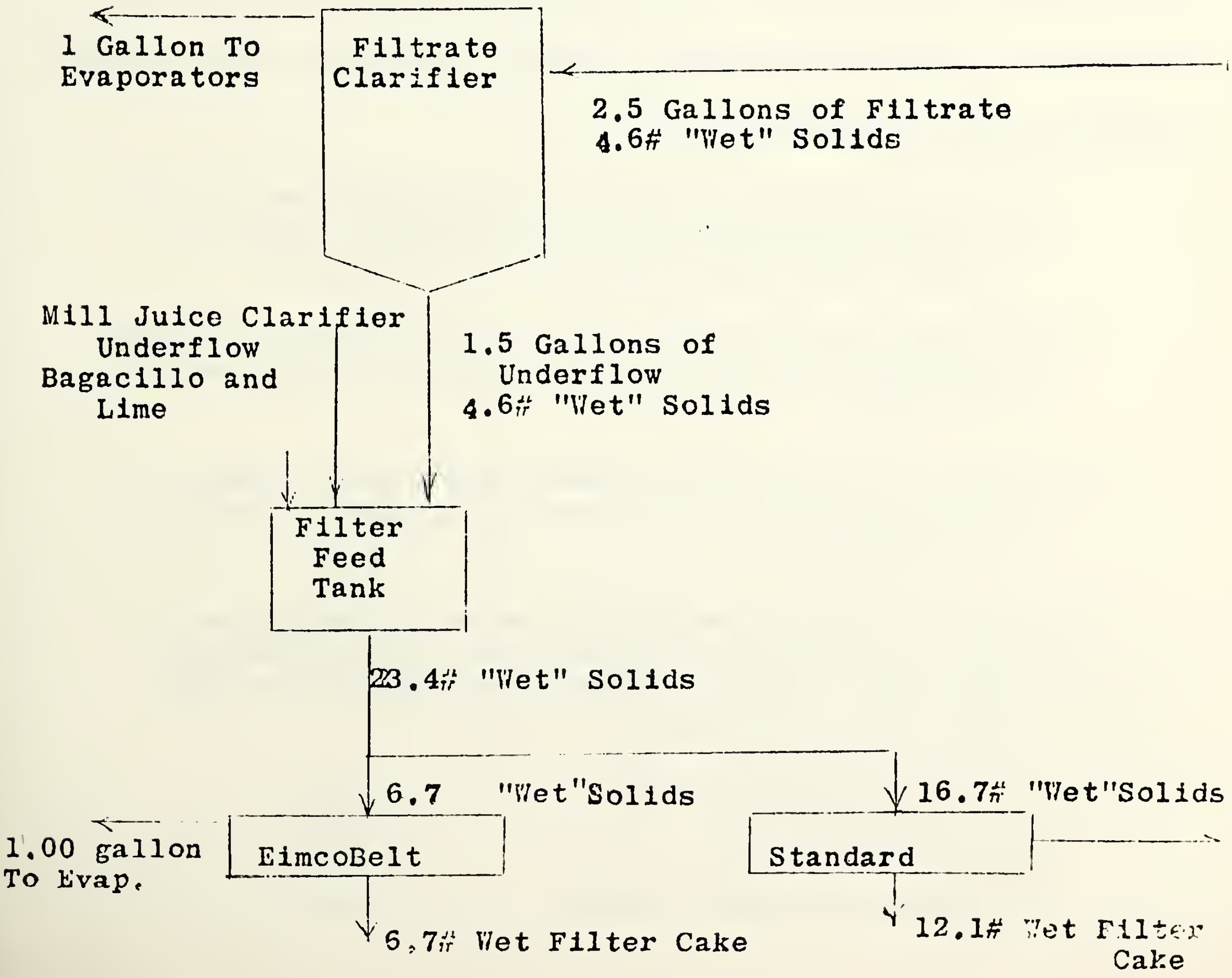
ILLUSTRATION 2

FLOW CHARACTERISTICS OF STREAM IN THE MILL

JUICE CLARIFICATION SYSTEM

BASES: One gallon of filtrate clarifier overflow and EimcoBelt filtrate.
One hour of operation and one square foot of filtration area.

Standard filtrate equal to 2.5 times the filtrate clarifier overflow or 2.5 gallons.



variance in filter cake composition for the two types of filters. The standard filters, because of their perforated screen, perform a "screening" action instead of the true filtration action of the EimcoBelt which employs a filter media tight enough to retain all solids. Therefore because the filter cakes from the two types of filters are obviously different in composition (the standard filter cake retains a higher proportion of coarse mud particles and bagacillo than the EimcoBelt cake), a true comparison would be to base economics on the production of clear juice - or that stream which is going to the evaporators and can be given a definite dollar value.

Comparative rates, based on the optimum EimcoBelt design, show that the EimcoBelt can produce more clear juice per square foot of filtration area than a standard type filter - clarifier combination. Other economic factors in favor of the EimcoBelt are:

1. The necessity for having 10 to 25 percent additional clarification volume for the dirty filtrate is eliminated. With the EimcoBelt filtrate goes directly to the evaporators.

2. Operating and maintenance costs involved in additional liming and heating of the dirty filtrate going back to sedimentation is eliminated.

3. Costly plant shut-downs or slow-downs caused, in part, by the recirculation of a dirty filtrate during bad mud conditions are eliminated.

4. Sugar recoveries are increased by using the EimcoBelt as a result of reducing the inversion caused by recirculating the dirty filtrate. Sugar yields can be calculated for the clarified streams and they were:

a. Filtrate clarifier overflow	87.2
b. EimcoBelt filtrate	88.2
c. Mill juice clarifier overflow	91.0

All of the above factors result in greater economic value for the EimcoBelt filter over a standard filter—clarifier combination. No absolute economic figures have been given because these absolute values would be dependent upon the particular sugar mill, the length of the crop, available clarification capacity, etc.

HOMEMADE INSTRUMENTS AT GLENWOOD COOPERATIVE

Luis A. Suarez

As you well know, the Instrument Industry is so advanced that in many cases it leaves one astonished. Their quality and performance nowadays are excellent, so it seems a homemade, simple and crude instrument should be something of the past and of no value.

Looking for a simple instrument that could be easily read and that would vividly attract the attention of operators, resulted into our homemade flow meter and level indicator.

After many years of experimentation, I have located a plastic tube that answers all my prayers. This tube has the characteristic that it can be punctured with a pin and automatically seals itself under pressure of up to 140 pounds per square inch.

My instrument is based on the following formula which is the basic flow equation applicable to flow meters utilizing a fixed-aerea restriction, located in the fluid stream:

$$Q = CA \quad 2gh$$

From the fundamental equation, this other is derived:

G.P.M. or pounds = K   64.35 x inches of water diff.

After selecting the size of orifice to be used, one can determine the value of the inches of water differential for any predetermined quantity using a Flow Meter Orifice Calculator. Knowing this variable in inches of water and gallons per minute, then the factor "K" can be found for these conditions. With this factor known, substitution in the above formula will show the inches of water differential for any flow rate.

Knowing the drop in pressure for different flows through a fixed orifice and after installing the plastic tube in a "U" shape on a plywood board, these drops are marked on the tube and, at these predetermined marks, a stainless steel pin is punctured where it will conduct electricity to a bulb when the mercury column closes the circuit.

A plywood board is made with 10 or 12 bulbs indicating the flow as they are lighted.

The most significant advantage of this type of flow meter is: first, its simplicity; then, its versatility; and last, but certainly not least, its advantage to indicate flow by a simple and inexpensive board that can be seen one to two hundred feet away and to be noticed by all men in the sugar house.

The idea has been very successfully expanded to measure levels in tanks and ponds. The principle is the same. We use an air pressure regulator set at 2 to 4 pounds per square inch, blowing air continuously in the tank or pond where level is to be indicated. The air pressure in the pipe is registered by the "U" column of mercury, lighting more bulbs as the level increases. We also use it to indicate level in our Steam Boiler Drums.

I wish to express my appreciation to Mr. H. M. Rhodes, employed with Frank H. Walk and Associates, for his cooperation in the development of this instrument.

CONTROL OF JOHNSON GRASS ON SMITHFIELD PLANTATION

Louis L. Arceneaux, Manager
Port Allen, Louisiana

For several years it was almost impossible to grow any row crops economically on Smithfield Plantation, because of it having a very serious Johnson grass infestation. Therefore, it was essential to inaugurate a control and eradication program of this grass.

In the spring of 1953, we set up a Johnson grass control and eradication program, with a system of fallow plowing and spring smother crops on lands following cane harvest. This method was encouraging, but results were not the best obtainable, mostly because very often stand failures were noticed in cover crops. However, this practice was continued for a period of a few years.

In the fall of 1956, in conjunction with our Johnson grass control program we introduced Mr. F. Evans Farwell's Clover System. In this system Alba Clover was planted using varieties Florana and Hubam on large acreage basis. The clover was planted following plowing out of stubble cane after harvest at seeding rates of about 15 to 18 pounds per acre.

This rather early planting of Alba Clover, customarily results in good stands and early development of root system minimizing freeze damage during winter. Our observation has been that a rank, heavy cover of clover during the winter and spring suppresses and retards development of Johnson grass that very few plants are noticeable during months of March, April, and May. In the latter part of May and early June, the clover has matured and dying falls down and causes a heavy close lying blanket of clover which continues to retard any appreciable grass growth. At or about this time, the fallow plowing process is resumed and continued as in previous years, replowing as Johnson grass growth requires.

In our fallow plowing practices, the first step is to plow under clover, by use of 16 inch, three or five bottom turn plows, keeping plows penetrating very deep. Following this operation land is disked and harrowed. Should it be permissible land is replowed, flushing it to center of cut, again using 16 inch, three or five bottom turn plows. Then land is rechopped and again harrowed with spring tooth harrow, followed by laying off of rows, at width of 5 feet 10 inches. Then the land is row plowed at intervals, up to time of fall cane planting.

Our four years experience planting Alba Clover, indicates that the best time for planting clover is from October 15 through December 15. Any clover planted earlier than October 15, most probably will have a large percentage of seeds killed by hot sun during dry periods in late fall. Clover planted later than December 15, will in some seasons grow out its cycle. However, there are chances to be taken in not getting a normal crop of clover, should it not be planted at a proper time. Therefore, we are of the opinion that if anyone expects to get optimum results from Alba Clover all precautions should be taken to reach such goal. Certainly the clover is most beneficial to anyone in building soils and combating all types of weeds.

In our operation we have a herd of approximately five hundred head of cattle, therefore, it is necessary to produce grass or bean hay. In order to get land to grow beans, we make a selection of areas with the least Johnson grass infestation. Prior to planting of beans, land preparation consists of capping-off stubbles to be destroyed, chopping down rows, and flushing land with three bottom disk plows. This operation is followed by disking and harrowing of land prior to planting beans. The beans are planted by use of a regular grain seeder, set to drill about seventy pounds of beans per acre. It is our policy to let the beans grow to a height of about three feet, before cutting them for baling. Of course, if for any reason we notice where Johnson grass will outgrow beans, they are cut and baled before Johnson grass seeds become mature.

Following bean hay harvest, land is flushed to center of cut by use of 16 inch, three or five bottom turn plows, keeping plows penetrating very deep, then land is left undisturbed for a short period. The next step is to disk, harrow and level land in preparation for laying off rows. Once rows are laid off at a width of 5 feet 10 inches, land is plowed at intervals as grass growth requires before preparation for fall cane planting.

RAILROAD RIGHT-OF-WAY, HEADLANDS AND DITCHBANK CONTROL

For several years headlands were contaminated with Johnson grass rhizomes and seedlings, causing a serious source of reinfestation for cultivated areas. Several methods were tried to control these areas, but response we obtained was minor. Therefore, a practice was established to chop and harrow all headlands accessible at intervals, mostly doing this work during rainy spells and after lay-by. We feel that since this method has been in practice our headlands have become free of Johnson grass.

In areas where clover, beans and fallow lands are, it is a general practice to ignore headlands and just plow through them when flat or flush plowing is done. Headlands not accessible to choppers or mowers are cut with hand blades, after lay-by.

In connection with ditchbanks, we start plowing banks as close to ditch as possible, early in January, continuing this practice up to lay-by time. Plus plowing, it is customary to mow banks often and continue up to time cane gets too tall. We agree not too much has been accomplished in grass control on ditchbanks, however, any effort made to prevent seeding of Johnson grass is beneficial.

Railroad right-of-ways certainly are a menace to plantations infested with Johnson grass, because of it being a breeding area for seedlings. In respect to our area we are fortunate in having good relationship and cooperation from the railroad officials of the Texas and Pacific Railroad Co., in assistance given us in weed control on Right-of-way. All of Right-of-way crossing the Plantation are sprayed once a year, using a mixture of sodium chlorate and calcium chloride.

CULTIVATION AND CHEMICAL PRACTICES

All stubbles where there is Johnson grass, are shaved, starting in late January or early February. In middle of February barring off of stubbles is started, using for this operation regular row plows with Pitre Hoes attached. Stubbles are off-barred at a width of sixteen to eighteen inches.

Immediately following barring off plows, stubbles are sprayed with chemicals, applying twelve pounds of T.C.A. and one and a half pounds 2,4-D per acre. At a later date middles are boxed and opened by use of a two row cultivator, preparatory to fertilization. Once stubbles have been fertilized and Johnson grass begins to be noticeable, spot spraying operations begin. Spot spray solution is prepared and applied according to L.S.U.'s chemical recommendations.

Cultivation is continued in stubbles up to lay-by time, which usually is in late May or early June. Following lay-by of stubbles a blanket spray is applied of one and a half to two pounds of 2,4-D per acre.

It is our practice to shave all plant cane, starting in early February, but the early shaved plant cane has no chemicals applied to it at time of shaving, unless the weather becomes warm and Johnson grass seeds begin to germinate. In such case four pounds of T.C.A. and one pound 2,4-D are applied per acre. When plant cane is off-barred another application of chemicals follows, using five pounds of T.C.A. plus one pound and a half of 2,4-D per acre.

After the cane is fertilized it is again sprayed with the T.C.A. plus 2,4-D mixture. However, in Johnson grass seedling areas, one pound of Dowpon is added per acre to T.C.A. and 2,4-D. Any Johnson grass plants remaining in plant cane after spray operation, is rogued out by use of hand hoes. Usual cultivation practices are followed in plant cane through lay-by. Following laying-by of plant cane, a blanket spray of 2,4-D at rate of one and a half to two pounds per acre is applied. Areas which have a history of heavy Johnson grass infestations are planted with cane varieties of good shading qualities. Following such a procedure in our planting program certainly has been advantageous.

We realize that a long time remains before Johnson grass will be eradicated on Smithfield Plantation. We do feel, however, that something has been accomplished whereby it is possible to grow a favorable crop of sugar cane.

SUGARCANE MOSAIC-VECTOR STUDIES IN LOUISIANA[1]

Leon J. Charpentier, Entomologist,
Entomology Research Division, Agr. Res. Serv., U.S.D.A.

Many growers recall through costly experience that sugarcane mosaic was considered one of the major factors responsible for the disastrous failures of susceptible varieties in Louisiana in the mid-1920's. The disease had satisfactorily been kept under control for some 25 years by the development, release, and general culture of resistant varieties. However, in recent years two high-yielding susceptible varieties, N.Co. 310 and C.P. 52-68, were released for commercial culture. Also, the recent identification of a new strain of mosaic and the fact that the disease has currently reached a role of economic importance in some of the most important present-day commercial varieties of sugarcane have renewed interest in the problem (1). At the present time mosaic is generally considered the most serious disease confronting the Louisiana sugar industry (2). Since varieties resistant to the new strain do not have other qualities required of a major commercial cane, the only known control is the roguing out of infected plants from fields that are to provide seed cane. This method is expensive and it reduces the stand of cane. In view of these developments and the great current concern in mosaic, joint cooperative studies with the pathologists of the Crops Research Division on several phases of the disease-vector complex, are being pursued.

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[1] Cooperative studies with Dr. E. V. Abbott and associates of Crops Research Division, sugar, and chemical companies. All mosaic determinations reported in this paper were made by pathologists of CRD.

A number of crop diseases are, of course, spread by insects in the field. Transfer of sugarcane mosaic from diseased to healthy plants was first demonstrated by Brandes (3), with the corn leaf aphid, Rhopalosiphum maidis, as the vector. Brandes stated that he did not believe that transmission of sugarcane mosaic was limited to this insect or even to other aphids. Later work by Ingram and Summers (4) demonstrated that the rusty plum aphid, Hysteroneura setariae, and the green bug, Toxoptera graminum, are vectors (5). A sedge aphid, Carolinia cyperi, fairly common in Louisiana but rarely found on sugarcane was found to be a vector in Puerto Rico by Tate and Vandenberg (6).

It was suggested by Brandes (3), and by Ingram, Haley, and Charpentier (7), that circumstantial evidence pointed to the sharp-nosed grain leafhopper, Draeculacephala portola, as a most likely vector because of its mode of feeding in the central whorl of the cane plant and since it is the most prevalent of all sucking sugarcane insects. This insect is the sole known vector of chlorotic streak disease of sugarcane.

Although ants are not directly responsible for mosaic spread, there is a close relationship between this insect and the known vectors of sugarcane mosaic. They play a very significant role in the dissemination of mosaic by carrying aphids from one sugarcane plant to another, from grass to cane, and vice versa. In the case of the rusty plum aphid, the ants will build protective dirt and borer-frass coverings over the aphid colonies to protect them against parasites and rains. The aphids attract and compensate the ants for their protection and care with honey-dew excreted from their bodies. This excretion constitutes a highly attractive food for the ants.

Studies were conducted to determine the number of the various known mosaic vectors, the sharp-nosed grain leafhopper, and of ants in relation to the rapidity of disease spread.

Single fields comparable as to variety, cane growth, soil type, drainage, and location on the plantation in each an area of historic heavy spread at Raceland and of light or no spread at Mathews were selected. In 1957, the studies were conducted in first-stubble of the variety C.P. 44-101 which presently occupies nearly 50 percent of the total cane acreage in the State. Each field was plotted into ten 20-foot random plots of 1-row each. Three of the plots were located on the fifth row from each side of the field and the remaining four on the middle row in each field. For observations, 20 plants taken at random in each plot, or 200 plants per field, were tagged. Five examinations were made during the period May 14-July 1. To determine insect populations on sugarcane it is necessary to examine all of the above-ground parts of the plants since the feeding places vary for the various known and suspected vectors. Results are given in Table 1.

These examinations showed over 8 times as many plants infested with the rusty-plum aphid in the heavy spread as in the light spread area. At Raceland the mosaic increased from an initial 60 to 74 plants, or 19 percent in 5 weeks. There was no incidence of the disease in the light spread area field at Georgia Plantation. It is believed the examinations were started too late in the season to show a tangible relationship between the abundance of this vector and degree of disease spread.

In 1959, the studies were conducted in the mosaic-susceptible variety N.Co. 310. Single row (1/100 acre) plots were plotted diagonally across four adjacent squares of cane in each area. In the heavy-spread area on Mary Plantation at Raceland there were 18 plots in first-stubble and 19 in the light-spread area on Georgia Plantation in second-stubble. Seed cane for planting the field at Mary had been taken from the field at Georgia.

Eight weekly examinations of all plants in each plot were made during the period April 7-June 4 to determine insect populations. Aphid and leafhopper counts were recorded on the basis of infested plants and ants on actual numbers. The results are summarized in Table 2. There was an average of twice as many plants infested with the corn leaf aphid, nine times as many with the rusty-plum aphid, and five times as many Argentine ants, Iridomyrmes humilis, in the heavy spread area as in the light area.

Average percentages of mosaic spread for the light and heavy areas were 1 and 10, respectively. In the field in the heavy-spread area the mosaic increased from an initial average infection of 39 percent to 43 percent, as compared to an increase from an initial 0.8 percent to 1.9 percent in the light-spread area. Of interest is the fact that in the field at Mary mosaic has increased to 39 percent infection by April 1959, after only 1 year, while the field at Georgia which had been the source of seed for the field at Mary, still has a less tha 1-percent initial infection after 2 years.

Three experiments consisting of single-row (1/100-area) plots in which a formulation of chlordane and malathion (1 ounce of each in 2 gallons of water per plot and application) to control ants and mosaic vectors were conducted in 1959. The treatments were applied with a hand sprinkler.

In the mosaic susceptible variety C.P. 52-68 plant cane at Waterford Plantation, Killona, La., 7 plots were treated and 7 comparable plots were used as controls. In the variety C.P. 36-105 plant cane on the same plantation the experiment consisted of 5 treated and 5 comparable control plots. The treatments were applied 3 times at bi-weekly intervals on April 20, May 4 and 18. Eight weekly examinations of 5-10 consecutive plant samples were made in each plot. The third experiment in C.P. 52-68 plant cane consisting of 5 sprayed and 5 comparable control plots in each of 2 squares was conducted at Raceland. The sprayed plots received the chlordane-malathion formulation on April 13, 20 and May 4 and 19. Nine weekly examinations of all plants in each plot were made during the period April 15-May 26. There was an average control of 76 percent of the corn leaf aphid, 100 percent of the green bug in 2 experiments in which this aphid was present, and 91 percent of ants. Average percentages of mosaic increases in the sprayed and controls were 67 and 90, respectively. The green bug was recorded on sugarcane in both experiments on Waterford Plantation only after crab grass, _Digitaria sanguinalis_, on which it had been present, was destroyed by hoeing.

The vector and ant populations at Waterford were unusually and generally light throughout the examination period. The sharp-nosed grain leafhopper population was generally at a high level.

In the fall of 1953, a 3-acre planting of the mosaic-susceptible variety Co. 290, with a low infection of mosaic, was made in heavy soil on the back of the plantation at Raceland, in cooperation with the Louisiana Agricultural Experiment Station. In April 1954, six 1/4-acre plots were plotted in this planting. Three of the plots received 3 applications of the systemic insecticide, Systox, at the rate of 2 pints in 30 gallons of water per acre with a low-gallonage sprayer on April 13 and May 10 and 29, and 3 alternate plots were used as controls. All mosaic-infected stools were rogued out before treatment. Two examinations of 100 plants in each plot, or 300 plants for each treatment and examination made on May 20 and 28, showed an average control of 100 percent of the corn leaf aphid and 90 of the rusty plum aphid. The population of both species of vectors was unusually low. Mosaic infection on June 16 averaged 2.9 percent in the sprayed plots and 2.1 in the controls. The high control of mosaic vectors obtained during May, normally the peak of secondary spread, was not reflected in a reduced incidence of the disease (8).

As a possible means of developing a program of decreasing mosaic spread by vector control with chemicals under current conditions, 2 experiments were conducted during May and June 1959 to evaluate the effectiveness of several insecticides for the control of the rusty plum aphid. They were located in sandy soil on the front of the plantations in stubble fields of the mosaic-susceptible variety N.Co. 310, which had rather heavy and uniform populations of the insect and of ants. The experiments were of a Latin-square design with 6 replications of each of 5 insecticides and of the control. Each plot consisted of a single row of cane, 25-feet long (1/48-acre per treatment), separated from the other plots by 12-foot side and end buffers. The chemicals were applied as emulsifiable concentrates, 1 pound active material in 30 gallons of water per acre, with a hand air-compressed sprayer. Two applications as foliage sprays were made 3 weeks apart, on May 13 and June 3. Seven weekly examinations for insect populations were made of all plants in a 10-foot sample, 7-1/2 feet from the ends of each plot.

In the experiment on Mary Plantation the performance of Heptachlor is of significant interest. Based on number of rusty plum aphid-infested plants and actual number of Argentine ants this insecticide gave the best control - 96 and 96 percent, respectively. It was followed by Systox - 89 and 89; Trithion, 87 and 84, Dimethoate 84 and 84, and Malation, 79 and 74. The control had a total of 331 aphid-infested plants and 1522 ants.

In the second experiment conducted on Georgia Plantation the only deviation from the preceding was the substitution of a 1/2 pound/acre rate of Dimethoate for the Heptachlor treatment. Percentages of control, also based on number of rusty plum aphid-infested plants and actual number of Argentine ants, were for Systox - 88 and 84, Trithion, 86 and 77, Dimethoate at 1 pound/acre, 84 and 80 at 1/2 pound, 84 and 78, and Malathion, 76 and 65, respectively. In the controls there were 242 aphid-infested plants and 780 ants.

Casual observations have indicated that the rusty plum aphid possibly had a preference for the mosaic-susceptible variety N.Co. 310. An ideal opportunity to get data on this developed in a stubble variety test field of the Crops Research Division on Mary Plantation at Raceland. This field had 4 replications of a number of varieties including N.Co. 310 and exhibited a rather heavy population of the aphid. Seven examinations were made in that variety and in C.P. 47-193 and C.P. 52-68 during the period May 4-June 30, 1959. Twenty-five plants taken at random in each of the 4 replications, or 100 plants for each of the 3 varieties, were examined on each date. There were 25 times as many aphid-infested plants in N. Co. 310 as in the C.P. 47-193 and 6 times as many as in the C.P. 52-68. The ant population was in line with the aphid population.

These data, observations, and miscellaneous counts indicate that the rusty plum aphid has a distinct preference for variety N.Co. 310. This preference is undoubtedly due to the larger collar lobe of that variety furnishing greater protection from rains and a larger food area for this aphid. The collar lobe is the favorite feeding position for the aphid.

An incomplete survey of several representative areas of the cane belt was made during May and June 1959 to determine the population and degree of infestation of the known mosaic vectors on some of the most prevalent and preferred host plants found in and around sugarcane fields. The examinations were made along roadways and ditches and on the front of the plantations. Results are given in Table 3.

The corn leaf aphid was found on all the plantations and was by far the most numerous. Infestation of Johnson grass, Sorghum halepense, whorls by this aphid ranged from 8 to 66 percent, with an average of 22 for the 21 plantations surveyed. Nineteen percent of the paille finne, Panicum hemitomon, whorls were infested on 5 plantations and 13 percent of the crab grass stools on 4 plantations. On 3 plantations, 15 percent of the sedge, (Andropogan sp.) was infested with the rusty plum aphid, and 12 percent of the crab grass by the green bug on the one plantation where it was present.

From these findings it would seem reasonable to assume that a general spread of mosaic in the sugarcane area may occur if a source of inoculum becomes available.

It would be well to point out and emphasize that in the United States Johnson grass has never been shown to be a carrier of the mosaic virus (9). However, this grass sometimes may be a very potent factor in mosaic dissemination in sugarcane. As we all know too well, it grows in profusion in and around cane fields on most sugarcane plantations in Louisiana and is one of the best host plants for multiplication of the corn leaf aphid, whose populations later migrate to infected hosts, if available, and institute mosaic epidemics in sugarcane.

Of significant interest and as a matter of record, the author in 1959 recorded for the first time in his long experience in the sugarcane mosaic disease-vector field, the definite establishment of corn leaf aphid colonies on sugarcane. This situation developed in variety N.Co. 310 and was first brought to our attention by Dr. E. V. Abbott, Plant Pathologist, Crops Research Division. In all of my and other investigators' past work, records of corn leaf aphid-infested plants represented a maximum of 1 or 2 specimens per plant and generally these were adults or winged individuals which always appeared to be in a state of restlessness on the sugarcane plant. In the 1959 studies the colonies remained in the whorls of the same plants indefinitely. The majority of the N.Co. 310 plants, recorded as infested by this vector, were infested by fairly large stable colonies of immature or wingless forms. Some movement of apterous individuals by ants was observed. It appears, therefore, that this variety in addition to being the preferred variety of the rusty plum aphid also harbors large populations of the corn leaf aphid, the most efficient of the four known mosaic vectors.

Greenhouse, insectary, and field experiments are being conducted in cooperation with pathologists of CRD, to determine whether insects other than the four known vectors transmit sugarcane mosaic and whether all transmission is by aerial vectors. Large-scale field tests with promising insecticides are anticipated to determine the feasibility of disease control through control of its insect vectors.

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Table 1. Number of sugarcane plants per two hundred of the variety C.P. 44-101 infested with various insects in areas of heavy and light mosaic spread in 1957.

	Heavy spread - Raceland			Light spread - Mathews		
Dates	Rusty plum aphid	Sharp-nosed grain leaf-hopper	Ants	Rusty plum aphid	Sharp-nosed grain leaf-hopper	Ants
May 14	12	28	42	0	28	3
May 27	4	22	16	0	14	7
June 13	4	32	32	2	19	14
June 21	8	29	25	2	12	15
July 1	6	14	27	0	10	10
Totals	34	125	142	4	83	49
Averages	7	25	28	0.8	17	10
Percent mosaic increases		19			0	

Table 2. Summary of insect counts in N.Co. 310 at Mary and Georgia Plantations, heavy and light mosaic spread areas, respectively in 1959.

	Heavy spread-Mary(1st Stub.)				Light spread, Georgia (2nd Stub.)			
Dates	Corn leaf aphid	Rusty plum aphid	Sharp nosed grain leaf hopper	Ants	Corn leaf aphid	Rusty plum aphid	Sharp nosed grain leaf hopper	Ants
April 7	0	0	0	235	0	0	0	62
April 16	17	5	17	170	7	0	10	25
April 28	138	119	77	779	31	14	99	99
May 5	74	144	105	639	83	9	21	117
May 12	29	87	134	411	8	17	106	139
May 19	8	81	153	428	0	8	116	116
May 26	0	182	193	922	0	11	123	139
June 4	0	141	206	551	0	21	148	157
Totals	266	759	885	4135	129	80	623	854
Averages	33	95	111	517	16	10	78	107
Average percent mosaic increases -				10			1	

Table 3. Mosaic vector survey data collected on host plants in and around sugarcane field in Louisiana, May and June 1959.

			Percent infested by		
Plantation	Grass	No. of plants or stools	Corn leaf aphid	Rusty plum aphid	Green-bug
Mary	Johnson	100	66		
	Sedge	25		28	
Youngsville	Johnson	100	46		
	Paille finne	50	32		
	Crab grass	25*	12		
Waterford	Johnson	100	41		
	Crab grass	50	16		12
Katy	Johnson	100	33		
Billeaud's	Johnson	100	29		
Alice C	Johnson	100	26		
Adeline	Paille finne	50	26		
	Johnson	100	21		
	Crab grass	25	12		
Landry's (S. of Lafayette	Johnson	100	23		
St. John	Johnson	100	23		
Albania	Johnson	100	22		
Idlewild	Johnson	100	21		
	Crabgrass	25	8		
Orange Grove	Johnson	100	21		
Oaklawn	Paille finne	100	20		
	Johnson	100	16		
Erath	Johnson	100	18		
	Paille finne	100	16		
Georgia	Johnson	100	10		
	Sedge	25		8	
	Paille finne	50	6		
Greenwood	Johnson	100	9		
Lower Terrebonne	Johnson	100	9		
Ashland	Johnson	100	8		
Little Texas	Johnson	100	8		
Glenwood	Johnson	100	8		
Southdown	Johnson	100	8		
	Sedge	25		8	
Total or average	Johnson	2100	22	-	-
	Paille finne	350	19	0	0
	Crab grass	125	13	0	12
	Sedge	75	-	15	-

*2 stools infected with mosaic.

THE 4-H SUGAR CANE PROJECT IN LOUISIANA

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The 4-H Sugar Cane project is one of some 34 projects offered to 4-H Club members in Louisiana.

Some of the major objectives of these projects and the 4-H club program in general could be stated as follows:

1. Help youth grow and develop (through each stage and phase toward adulthood).
2. Help boys and girls to learn facts, skills, and techniques (so they will be ready, prepared, and adequate for service in the complex technical age ahead).
3. Provide opportunity for youth to develop lasting and satisfying attitudes toward life and toward other persons.

Sugar cane has never been as popular as a project compared to such projects as Dairy Calf, Beef Calf, etc. This is probably due to its heavy labor requirements, operation of mechanical equipment and the time of the year that it requires more attention coincides with school, etc.

Realizing these conditions, E. R. McCrory, then associate agronomist with the L.S.U. Agricultural Extension Service, in 1950 outlined a sugar cane for seed increase project. This made it possible for 4-H club boys along with farmers to receive 10 free stalks of each new variety released by the Experiment Station.

Fifty-seven club members in St. Martin Parish received each 10 free stalks of C.P. 43-47 that year - fall of 1950.

Mr. McCrory's idea of including club members to receive 10 free stalks of each new variety has no doubt increased interest and made the project a more practical one especially those with limited facilities for growing sugar cane. It has also caused new varieties to be planted on many more farms sooner than would have otherwise occurred. Many farmers have remarked in French "I first observed the variety I'm now growing when my son got it thru his 4-H club work."

State Fair premium for Junior exhibitors of Sugar Cane was first offered in 1951 (for exhibits of C.P. 43-47 planted in the fall of 1950). This was another step toward encouraging and increasing interest in the Sugar Cane project.

At a series of club meetings a few years ago the Associate County Agent of St. Martin Parish gave a method demonstration to club members on Sugar Cane and Sugar Cane varieties. The aims of these demonstrations in the form of a short lecture and a quiz afterward were to acquaint club members with the importance of Sugar Cane in St. Martin Parish and to help members identify popular varieties and learn their adaptability to different soil types, etc. (A copy of this method demonstration and quiz is attached.)

NOTE: It was surprising to learn by asking a few questions before the demonstration how little was known about this leading crop and industry in St. Martin Parish, and how much interest the club members showed even though the information was given in the form of a "talk."

In 1957 a newly inaugurated sugar cane project was announced by Denver T. Loupe, Asst. Agronomist and the State 4-H club office of the L.S.U. Agricultural Extension Service. The minimum requirements for this project are:

1. Have facilities for planting and producing a minimum of 1 acre of sugarcane, preferably 1 cut.
2. Select and display exhibits at fairs and shows.
3. Submit project records to agent when requested, with a map from the A.S.C. (Agricultural Stabilization Committee.)

At about the same time Mr. Loupe and the State 4-H club office in cooperation with the American Sugar Cane League announced a 4-H Sugar Cane contest.

Requirements for the contest were set as follows:

To be eligible for an out-of-state trip, contestant must be a senior club member. In addition, he must have:
   a. Satisfactorily completed his project.
   b. Exhibited sugar cane at a particular fair or show.
   c. Taken a test and judged sugar cane.

The awards as set up for the contest are based on the following:

a. Project Record Book (including story of project)	100 points
b. Production Record (tons of standard sugar cane per acre)	250 points
c. Exhibit	50 points
d. Judging and test	100 points

Records for the first annual contest sponsored by the American Sugar Cane League, for the 1957 crop were called for in the spring of 1958.

St. Martin Parish was "lucky" to have the first state winner in this contest. He was Raymond Boudreaux, a member of the St. Martinville High School 4-H club.

Raymond's project consisted of 3.6 acres of C.P. 44-101. He harvested an average of 21.8 tons per acre (year of Hurricane Audrey) having an average sucrose of 12.38 and an average purity of 79.86. Standard tons per acre amounted to 23.2 and total recoverable sugar was 36.53 cwt.

His per acre expenses for seed cane, fertilizer and labor (self and father) amounted to $62.45. On basis of Sugar Cane delivered to the mill his per acre receipts amounted to $147.69 or a total net income of $85.24 per acre. It must be pointed out that no allowance in expenses were made for land rent„ use of machinery, etc.

Raymond's father is a relatively small sugar cane grower who farms 45 acres of Sugar Cane and 40-45 acres of other crops, mainly corn and soybeans. Raymond and his father and his younger brother do all the field work except for hiring a mechanical cane cutter. Raymond operates the tractor and does field work on Saturdays and after school.

When the records for the second annual contest (for the 1958 crop) was called for and judged, St. Martin Parish was again fortunate to have one of its members declared State winners. He was Sidney Hebert III. His project consisted of a 3 acre plot which was idle for a year - and had been a garden (truck crops) plot for several years previous.

The sugarcane (C.P. 36-13) was planted in September 1957. Sidney did much work as driving the tractor while others planted, covering and packing.

The results of this project can best be told by quoting from his story submitted with his project records for the contest.

"The harvesting was done on December 4-5. The weather was crisp and clear. The three acre plot yielded 104.940 tons. While the loss on trash was 3.302 tons the Sucrose gain amounted to 6.049 tons making a total of 107.687 standard tons. These 107.687 standard tons brought a total receipt of $694.47. The molasses payment amounted to $23.02. We also received $136.71 for the bonus. This amounted to $854.20 receipts from the three acres owned by my sister and me. The 10% kept by the mill amounted to $78.35. This according to the agreement with our parents was given in payment for all expenses. The American Sugar Cane League dues of $1.52 was also deducted from out total receipts, leaving my sister and me $774.33. This was divided between my sister and me and our share was each $387.16. The money that I have made and the money that I hope to make will be used for my college education later on.

"In entering the Sugar Cane project I have derived a special pleasure from working in the soil and watching a crop grow into something profitable. It was interesting to learn how mill records are kept and how each load of cane is tested for purity and sucrose in order to determine just what the cane is worth.

"Even now, with the stubble from last year's plant cane, I am looking forward to another year of hard work with a promise of some profit, achievement, and satisfaction in doing something worthwhile and most interesting."

It must be noted that the high amount received by Sidney ($387.16) is due to the special arrangements with his parents to "Charge" only 10% for all expenses. Sidney's parents gave him additional acreage for his 1958-1959 project.

His exhibit (3 stalks) of sugarcane was declared "Champion" at the 1959 Sugarcane Festival and Fair, and he received the $200 cash premium sponsored by the American Sugar Cane League. His parents operate a 700 acre farm (over 300 acres is sugar cane) on a fifth basis. The parents' foresight and planning for the future college education of their son and their daughter through this 4-H project will not only provide much of the needed funds, but perhaps most important, will develop in him an appreciation of such.

Through the cooperation of the American Sugar Cane League each of the above contest winners received a free trip the year they won to the International Livestock Show held in Chicago. They went as part of a group of other 4-H State crop and livestock contest winners.

They, along with their parents, were recognized at the annual luncheon and meeting of the American Sugar Cane League.

It is hard to describe the enjoyment and experience the club members got out of the award luncheon and trip. One can "sense" the feeling of the parents of those boys as they watched their sons receive those awards. There is little doubt that when parents take such interest in their child's activities and when other organizations such as the American Sugar Cane League, the Agricultural Extension Staff, 4-H Local Leaders and other adults show interest and give encouragement, the over-all objective of 4-H club work of helping develop boys and girls into useful citizens will be reached.

SUGARCANE AND SUGARCANE VARIETIES

Outline of Method Demonstration for
4-H Club Members in St. Martin Parish

AIMS:

(1) To acquaint club members with the importance of sugarcane in St. Martin Parish.

(2) To help members identify popular varieties and learn their adaptability to different soil types, etc.

CONDITIONS:

(1) Sugarcane is the most important crop in the parish.

(2) Nature of work, particularly harvesting, makes it somewhat impractical as a definite project, except for older club members.

 (a) Results in little attention or interest.

 (b) Results in lack of knowledge concerning work of Experiment Station and others with variety tests, etc.

(3) Three sugar mills in the parish making that the most important industry also in the parish.

DEMONSTRATION OUTLINE

Points to be stressed:

(1) Importance of sugarcane in parish.

 (a) Ranks first in farm income.

 (b) Approximately 500 farms growing 17,500 acres.

 (c) Three sugar mills in parish processing sugarcane.

  1. Employs many people.

(2) Recommended Varieties

- (a) Importance of planting recommended varieties.
  - 1. Type of soil, etc., affect yield.
  - 2. Four leading recommended varieties.
    - 2. Name and description of each, using samples.
- (b) Work of Experiment Station
  - 1. Develop new varieties
    - a. According to sucrose, habit of growth, resistance to disease, time of maturity, etc.
  - 2. Test yield of different varieties in different sections.
    - a. Recommends best suited after years of testing.

(3) Diseases

- (a) Mosaic
  - 1. Threatened sugar cane industry around 1926.
  - 2. Many present varieties are not resistant to it.
  - 3. Symptoms
  - 4. Very little found in St. Martin Parish at present.
    - a. Roguing done to obtain mosaic-free seed cane for planting.
- (b) Ratoon Stunting Disease
  - 1. No definite symptoms.
  - 2. Reduces suckering and vigor and yield.
  - 3. Heat treatment of cane to be planted for more disease-free plantings.
  - 4. Method of spreading.

(4) Insect Pest

  (a) Sugarcane borer.

    1. Most common and destructive pest.

      a. Considerable damage last few years.

    2. Method of determining presence and extent of damage.

      a. Control measures if necessary.

(5) Marketing Crop

  (a) Sugar mill purchases on sucrose and purity test.

    1. Explanation of "normal test."

      a. Penalized below normal.

      b. Premium above normal.

MATERIALS NEEDED:

(1) Samples of four leading varieties in the parish.

(2) Agricultural Extension Publication 1184 - Louisiana Sugarcane.

(3) Agricultural Extension Publication 1206 - Sugarcane for 4-H Clubbers.

(4) Simple test (filling in blanks).

REFERENCES:

(1) Local data.

(2) Agricultural Extension Publication 1184 - Louisiana Sugarcane.

ACTIVITY FOR CLUB MEMBER:

(1) Give prepared test at end of demonstration, awarding 1st, 2d, and 3d prizes, made possible from sugar mill contribution to the 4-H Fund Drive.

(2) Distribute Agricultural Extension Publication No. 1206 "Sugar Cane for 4-H Clubbers" to those interested.

Name________________________________Club__________________________

A TEST ON SUGARCANE FOR 4-H CLUB MEMBERS OF ST. MARTIN PARISH

1. Sugar cane ranks _____(1st, 2d, or 3d) in St. Martin Parish.

2. There are approximately ____ farms growing approximately ______ acres of sugarcane in the parish.

3. Make a circle around the three leading varieties of sugarcane recommended for St. Martin Parish. (CP 44-101), (CP 36-105), (CP 52-68), (N.CO. 310), (CP 43-47), (CP 44-155).

4. All above varieties grow well in any type of soil. ___________________
(true) (false)

5. Different varieties have different characteristics which make some better suited to certain conditions. _____________
(true, false)

6. Name the sugar mills found in this parish:
1.____________________________2.______________________________
3.____________________________

7. Underline the name of the disease that threatened the sugarcane crop in the 1920's. Ratoon Stunting, Mosaic, Damping Off. You can recognize this disease by (1) the large holes in the sugarcane barrel, (2) the yellowish-green discolorations or mottling in the leaves, (3) round holes in the leaves. (Underline the correct answer).

8. The most common insect pest of the sugarcane in our parish is the
______________________________ _________________________.

9. We are able to have new and better varieties usually when needed, principally because of the work of the ____________ ________________.

10. The _________ and __________ tests tell how much sugar is in the sugarcane and determine the amount of money a farmer will receive for each load of sugarcane he takes to the mill.

11. The normal sucrose test of sugarcane is __________________________.

12. The normal purity test is ___________________.

BREEDING IN SUGARCANE WITH SPECIAL REFERENCE TO KINDS OF MATERIAL

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Sugarcane appears to be native to southeast Asia and islands off the coast. It is known from records to have been grown as an economic plant in that part of the world for at least 2,500 years and undoubtedly its use preceded that date by several hundred, perhaps several thousand, years. It is also of interest that, although several species of the genus Saccharum have been found, all species are native to the same rather limited area. Unlike many other genera of plants, the genus Saccharum was not widely distributed in its native habitat. There are no species which are native to the New World, Europe, Africa, or even Hawaii and Australia.

In fact, the growing of sugarcane outside southeast Asia and such islands as Java, Ceylon, and New Guinea is a relatively recent development, with introduction into southern Europe between 700 and 750 A.D. Of course, its production in the New World did not come until the colonization period in the West Indies and South America following the discovery.

One fact of considerable significance in the breeding of sugarcane is that the original cultivated species, Saccharum officinarum, has extremely little genetic variation among existing varieties or clones in contrast to the large number of genetically different varieties of such plants as rice and wheat which were in existence long before modern plant breeding began. In fact, the early history of sugarcane production in southern Europe and the New World before 1800 was based almost entirely on a single clone or variety, Creole, which apparently came originally from India. In the early 1800's, a few additional varieties, such as Black Cheribon (La. Purple) and Preanger (La. Striped) were introduced from Java and other islands of that region. However, as late as the 1920's, most of the world production of sugarcane was based on not more than 8 or 10 clones of the species S. officinarum. At the same time, thousands of genetically distinct varieties of rice and wheat were already being grown. This extremely narrow range of variation among varieties of sugarcane was due undoubtedly to its vegetative propagation, which does not permit much genetic variation to occur naturally.

In the modern system of taxonomy or classification, five species of Saccharum, or sugarcane, are recognized. Three of these are cultivated species, - S. officinarum (noble cane), S. barberi and S. sinense -- and two species, S. spontaneum and S. robustum, are wild forms. Although valueless for agricultural production, the wild species have been of great importance in the improvement of cultivated sugarcane through plant breeding.

Modern sugarcane breeding may be considered to have begun with the discovery about 1890 that the plant is capable of producing viable seeds. Prior to that time all breeding was based on selection in clones under vegetative propogation, which leads to very slow change of an uncertain nature. The utilization of true seeds allowed the cane breeder to take advantage of the much greater genetic variation that is possible from sexual reproduction. However, there was a long period of trial-and-error effort after the recognition that sugarcane produces true seed before an effective breeding method based on sexual reproduction could be devised.

For many years after the discovery of seed, sugarcane breeding was limited primarily to open pollinated seed from the leading agricultural varieties of noble cane, S. officinarum. This was a natural procedure to adopt but unfortunately it led to very little improvement although tried on a wide scale by many experiment stations. The main reason for limited success from open pollinated seed of noble varieties was probably the very narrow range of genetic variation within S. officinarum, a condition emphasized earlier. Although noble cane is highly superior in such traits as sucrose content, fiber content and size of barrel, none of the varieties of this species possesses genes for resistance to the major diseases of sugarcane or for adaptibility to subtropical regions.

Failure to obtain many superior new varieties from open pollinated seed of noble varieties had a profound effect on the early history of sugarcane breeding. This method was abandoned and breeders were forced, more-or-less, at an early date, into the use of hybridization between species in an attempt to improve noble cane. It is apparent now that this procedure was essential in the breeding of sugarcane.

It is generally known that interspecific hybridization in sugarcane breeding was begun in Java shortly before 1900. The first hybrids were between varieties of noble cane and the Chunnee variety, belonging to the cultivated species S. barberi, from India. The objective was to combine resistance to the sereh disease from Chunnee with desirable characteristics of noble canes. The Java experimenters were only partially successful in meeting this objective. Several varieties were released from these crosses, including P.O.J. 36, P.O.J. 213, and P.O.J. 234, but they were never successful in Java. However, these were introduced into other countries where they were grown extensively for a period. These were the P.O.J. varieties which were brought into Louisiana in the 1920's and helped save the sugar industry here.

It is ironic that failure of the crosses between Chunnee and noble varieties to produce types which were acceptable for growing in Java forced sugarcane breeders there into another, more difficult, type of hybridization which led, however, to development of the most valuable material yet produced in sugarcane breeding - hybrids with the wild species S. spontaneum. Like many successful ventures, however, this research was characterized by failures and unpromising results during the earlier phases. Perhaps it only appears that the most valuable results have been achieved from research that seemed unpromising for a long time but there are numerous examples of this phenomenon.

About 1890, a large, vigorous wild form of sugarcane, known as Kassoer, was collected in Java and found from observations to be immune to the sereh disease. This wild form differed considerably from common wild S. spontaneum and was considered for many years to represent a separate species but in 1915 Jeswiet proposed that Kassoer is a natural hybrid between the Java form of S. spontaneum and a variety of noble cane, Black Cheribon (La. Purple), that had become established in nature. During the period 1893-1915, several workers in Java made numerous crosses between Kassoer and various varieties of noble canes in an attempt to utilize its immunity to sereh disease. It is apparent that this was done without recognition that the Kassoer parent was a hybrid and that the crosses constituted what is known in plant breeding as the first backcross to the parent species S. officinarum. Although carried out on an extensive scale, none of the noble cane X Kassoer offspring proved to be suitable for agricultural production because, although many were immune to sereh, all possessed inferior traits from the wild Kassoer parent. Thus, the results from the first 20 years of this line of research were highly unpromising and each worker who made these crosses soon abandoned the procedure.

Despite the unpromising nature of the progeny from crosses between noble canes and Kassoer, attempts to obtain something of value from them were continued intermittently, probably because no other breeding technique was successful in solving the sereh problem. Then, in 1916 Jeswiet modified the approach somewhat by crossing sereh immune offspring from Kassoer X noble hybrids with noble cane varieties rather than continuing to cross Kassoer itself with the nobles. This step represented the second backcross to noble and would be expected to produce progeny which resembled noble cane more closely than did the first backcross offspring. The results showed immediate promise. Many progeny from the second backcross were not only immune to sereh, an immunity derived originally from the wild species S. spontaneum through Kassoer, but resembled noble cane sufficiently in other traits to be grown agriculturally. Some of the varieties derived from this second backcross were P.O.J. 2714, P.O.J. 2725, P.O.J. 2878, and P.O.J. 2883. P.O.J. 2878 quickly became the leading variety in Java. These varieties were later introduced into other tropical countries and became highly important there. The procedure came to be called "nobilization."

Although the P.O.J. varieties developed from Kassoer hybrids were not well adapted in such subtropical areas as Louisiana, they, along with the earlier varieties from Chunnee hybrids and varieties developed in India by the nobilization procedure from crosses between noble canes and an Indian form of S. spontaneum, proved to be extremely valuable as parental material for breeding programs in those areas. Virtually all of the C.P. varieties that have been grown in Louisiana trace back to these three sources, all representing interspecific hybridization. Of importance in the breeding program in Louisiana, the interspecific hybrids were found to be resistant to other diseases, such as mosaic and red rot, and to be earlier in maturity than noble cane, a characteristic which improved their adaptability to this subtropical region. The major variety C.P. 34-120 had in its parentage three major sources of superior genes from interspecific hybrids - S. spontaneum of Java through Kassoer, Chunnee through P.O.J. 213 and S. spontaneum of India Co. 281. Thus, for the past 25-30 years, sugarcane production in Louisiana has been based on varieties developed from interspecific hybrids made in Java and India.

The remarkable success from early trial-and-error use of hybridization between species before there was an understanding of the material being utilized suggests that even greater improvement might be realized from application of our current knowledge concerning principles of genetics, cytogenetics and plant breeding. As pointed out earlier, the varieties which we grow now trace back to two species in addition to *S. officinarum*, *S. barberi*, and *S. spontaneum*. However, only two forms of *S. spontaneum* were involved in the material, the Java form and one from India. It is recognized now that many other forms of the wild *S. spontaneum* occur in India, Burma, Sumatra, and other areas. These other forms differ genetically from the two used previously and probably contain genes that would be of value in a cultivated cane for Louisiana. Little is known concerning the potential value of the other wild species, *S. robustum*, for the improvement of sugarcane. It is the feeling of the speaker that other wild forms of the genus Saccharum could probably be utilized in the breeding of sugarcane and that fundamental research in this field designed to determine the value of other wild forms would be worthwhile.

TECHNICAL ASPECTS OF THEORETICAL MILL SETTINGS

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"Setting" a sugar mill consists of selecting the most favorable relative positions of the three rollers and the turnplate, in order to obtain the best conditions of feeding and best extraction results.

Mill settings can be predetermined with considerable accuracy. In any case, they can be figured closely enough so that no major change should be necessary.

This paper covers the theoretical technical aspects of this subject, and includes charts for rapid calculations of settings for any particular set of conditions.

The opening between rolls is determined by the combined volume of compressed fiber and juice diluted with water. Since the bagasse roll opening is where the maximum pressure is applied, it is always this opening that is calculated first. The cane roll opening is then calculated, as will be discussed later.

Bagasse Openings

The thickness of the bagasse blanket determines the bagasse roll opening, and equals the thickness of the fiber blanket plus the thickness of the moisture blanket.

$$Th = Th_f + Th_m \text{ - } (1)$$

1. Thickness of the fiber blanket.

$$Th_f = \frac{\text{cubic inches of fiber per minute}}{\text{square inches of roll surface per minute}}$$

For one short ton of cane per 24 hours per inch of roll face - per foot per minute of roll speed for cane with 10% fiber this becomes:

$$Th_f = \frac{1 \text{ ton} \times 2000 \times .1 \times 1728}{24 \text{ hr} \times 60 \frac{\text{min.}}{\text{hr.}} \times WT_f \times 12} = \frac{20}{WT_f} \text{ - - - - - - - - - - -} \quad (2)$$

WT_f = Weight of fiber under compression.

2. Thickness of moisture blanket.

Th_m depends on the ratio m/f of the percentage by weight of moisture and fiber in the bagasse.

From eqn. (2) above the thickness of the fiber blanket $Th_f = \frac{20}{WT_f}$

$$Th_m = Th_f \times \frac{WT_f}{WT_m} \times \frac{m}{f} = \frac{20}{WT_f} \times \frac{WT_f}{WT_m} \times \frac{m}{f} = \frac{20}{WT_m} \times \frac{m}{f} \text{ - - -} \quad (3)$$

$$\text{Then } Th = \frac{20}{WT_f} + \frac{20}{WT_m} \times \frac{m}{f} \text{ -} \quad (4)$$

As an aid toward a consistent means of assuming percentage of moisture after each mill in tandems of various numbers of rollers, Fig. 1 has been prepared. From this the ratio $\frac{m}{f}$ for a six-mill unit with a three-roll crusher is as follows:

Mill No.	1	2	3	4	5	6
$\frac{m}{f}$	$\frac{67}{33}$	$\frac{60}{40}$	$\frac{55}{45}$	$\frac{52}{48}$	$\frac{50}{50}$	$\frac{48}{52}$

These figures are assumed to be after the bagasse leaves the bite and reabsorption takes place. Assuming reabsorption takes place more toward the end of the tandem, Fig. 2 has been constructed to take this into account for use in making calculations for the roll opening chart.

FIG. 1

m/f Ratio for Various Numbers of Units

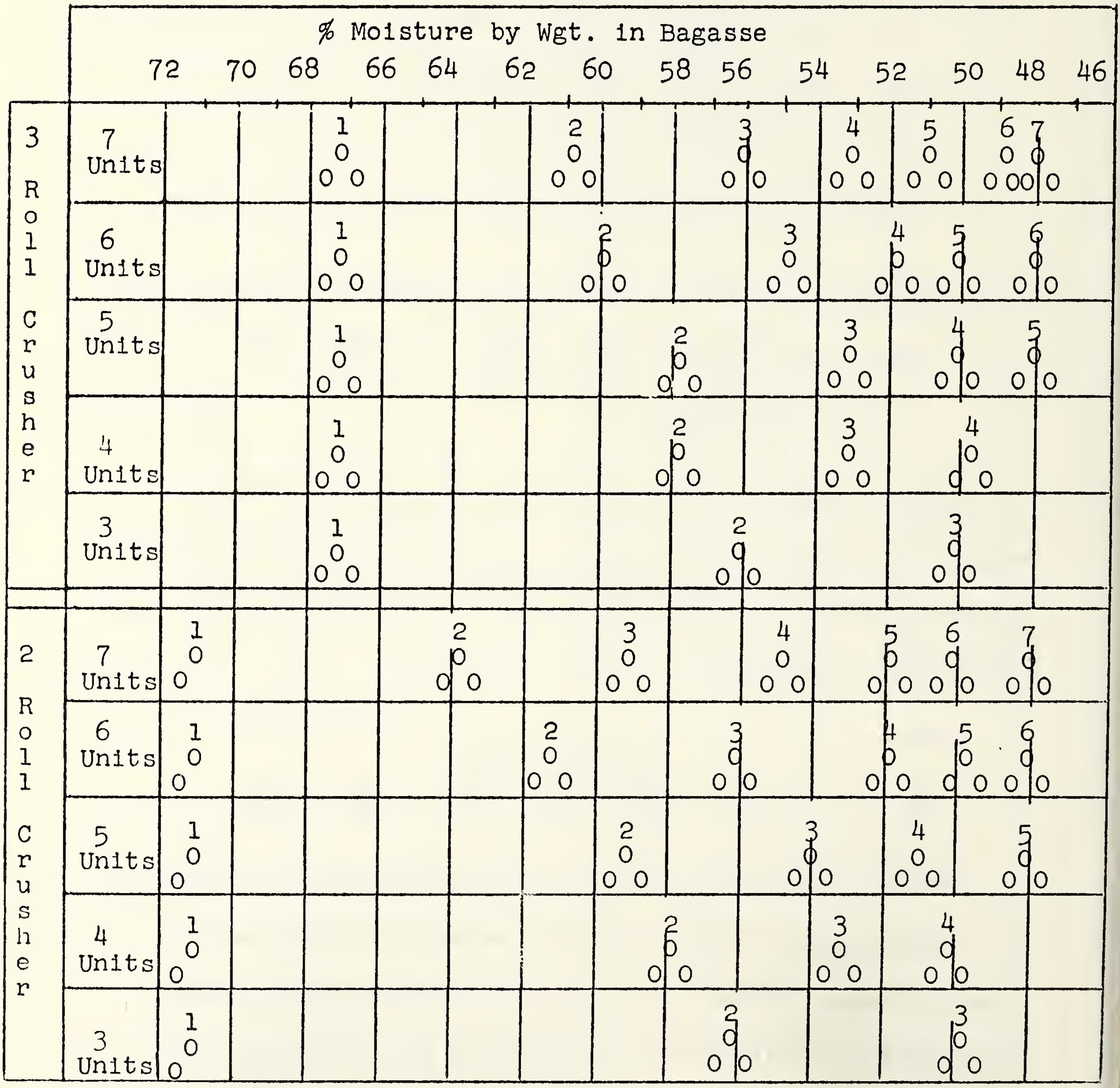


FIG. 2

Relationship of Bagasse Moisture in Bite and After Leaving Bite

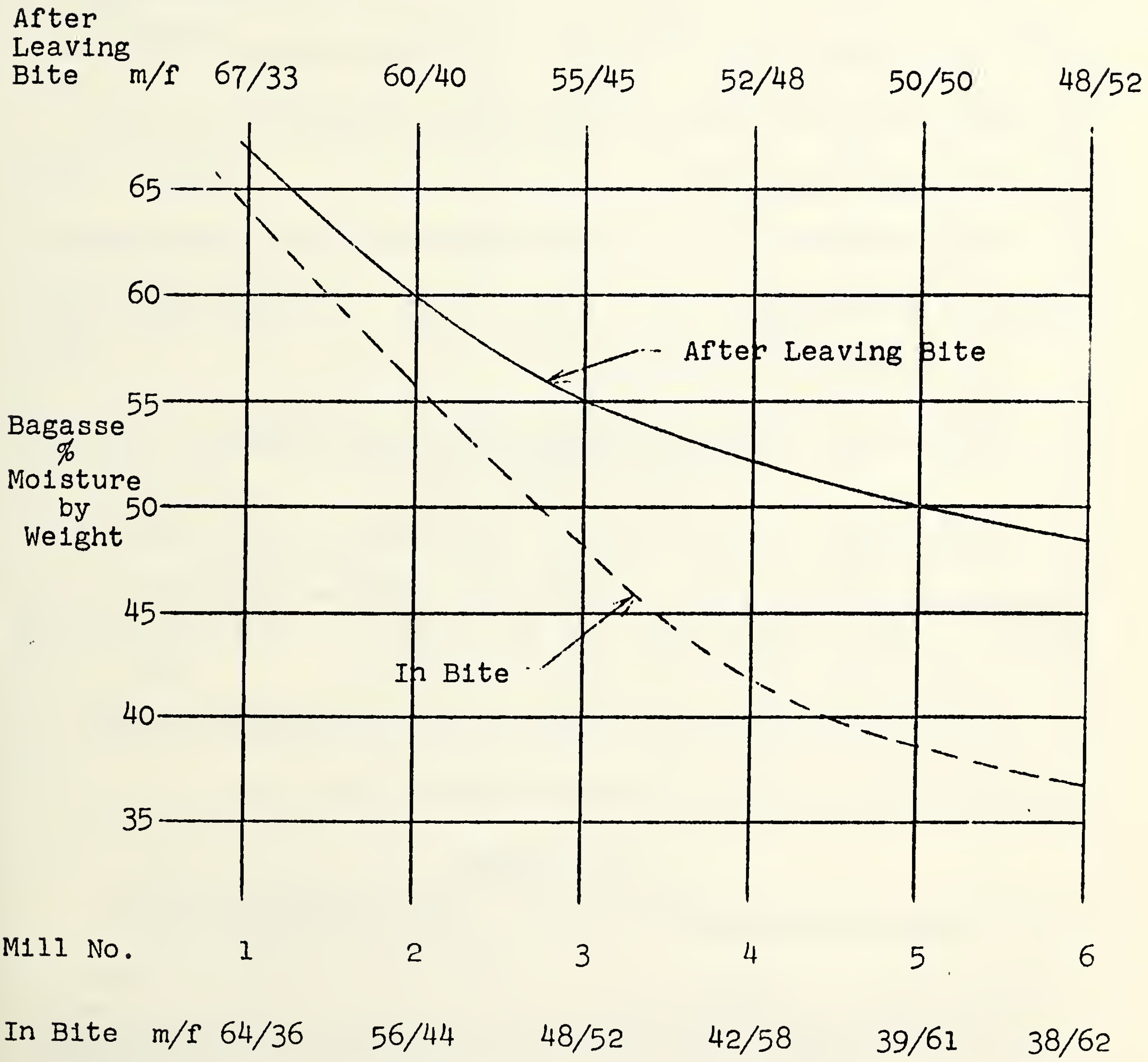


TABLE A gives various assumed values and calculations used to determine the total blanket thickness "Th" which equals "0".

"0" = Total Bagasse roll opening per short ton of cane per
24 hours - per inch of roll face - per foot per minute
of roll speed - for cane with 10% fiber.

These values for "0" are plotted against the percent of moisture by weight in the bagasse after leaving the bite resulting in Fig. 3. From this figure, the unit bagasse roll opening for any theoretical (or actual) moisture can be taken directly.

Using this value of "0", the actual bagasse roll opening for a given set of mill conditions is -

$$\text{Actual Opening} = \text{"0"} \times \text{Factor} \tag{5}$$

$$\text{Where Factor} = \frac{\text{Short tons of cane per 24 hrs.} \times \text{\% fiber}}{\text{Face (inches)} \times \text{Speed (FPM)} \times .1} \tag{6}$$

Modifications must be expected. No allowance has been made for bagacillo returned from strainer, conditions of rolls, etc. However, these modifications apply more to cane roll openings.

These openings are pitch line to pitch line of grooving, or in case of same grooving in top and bagasse roll they are point to root.

Cane Openings

The opening between the top and cane roll cannot be determined with any accuracy. It should be the smallest possible without causing choking. It should obviously be greater than the bagasse opening; if they were made equal, either the output of the mill would be ridiculously low (small openings), or the pressure would be very poor (large openings).

TABLE A

ASSUMPTIONS AND CALCULATIONS FOR CURVES ON FIG. 3

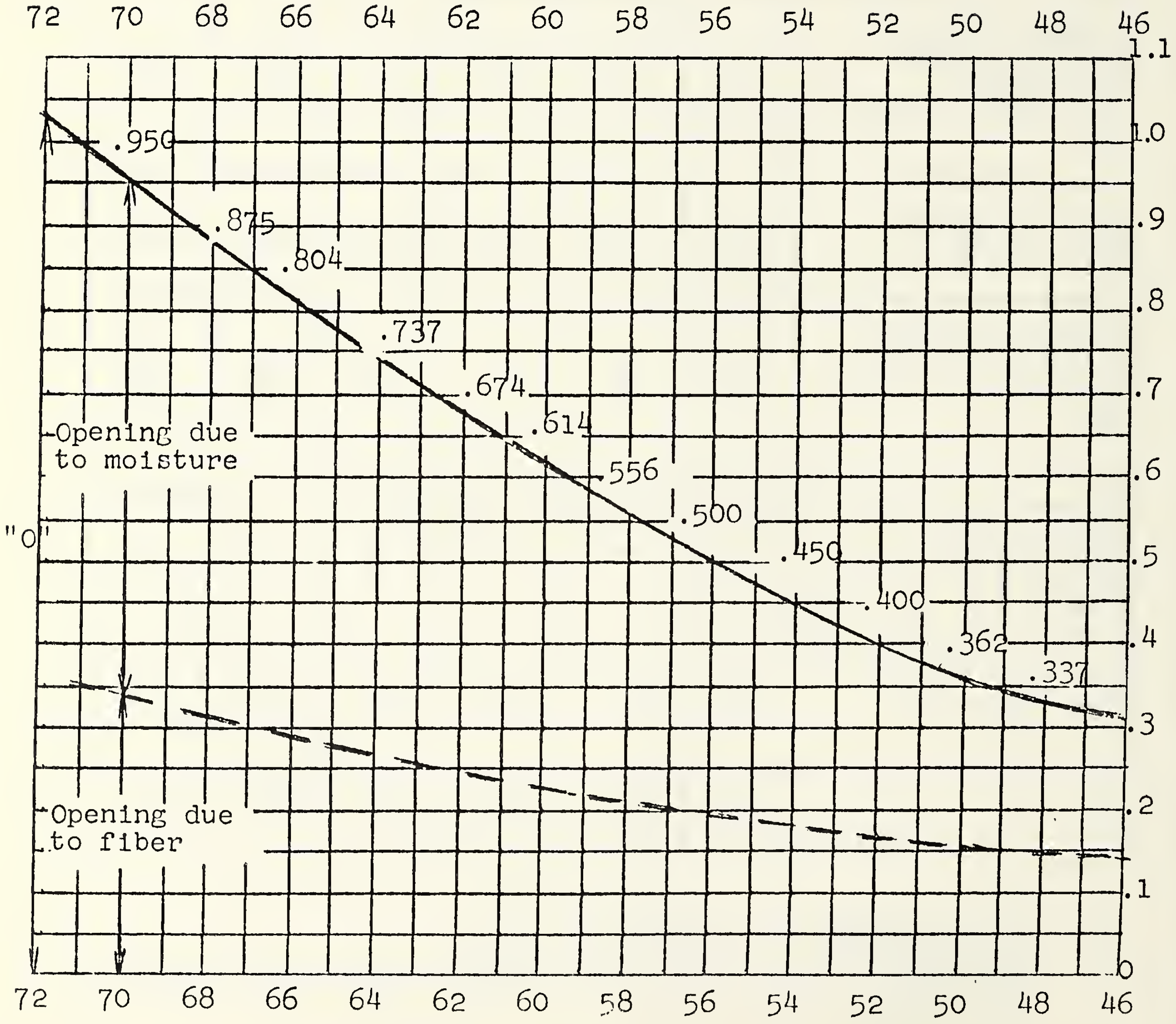
Assumed % moist. by wgt. of bagasse after leaving bite	67	60	55	52	50	48
Assumed density of fiber under compression lbs. per cu. ft. WT_f	66	87	105	116	126	135
Fiber Blanket $Th_f = 20/WT_f$	.302	.229	.191	.173	.159	.148
Assumed % moist. fiber ratio under compression in nip m/f	$\frac{64}{36}$	$\frac{56}{44}$	$\frac{48}{52}$	$\frac{43}{57}$	$\frac{39}{61}$	$\frac{37}{63}$
Assumed density of moisture lbs. per cu. ft. WT_m	← Pure 66	Juice → 66	← Dilute Juice → 65	64	63	← Water → 62
Moisture Blanket $Th_m = \frac{20}{WT_m} \times \frac{m}{f}$	.538	.385	.284	.227	.203	.189
Th = "O"	.840	.614	.475	.400	.362	.337

"O" = Total Bagasse Roll Opening
per short ton of cane per 24 hours -
per inch of roll face - per foot per minute of roll speed -
for cane with 10% fiber.

Actual Openings (For given mill condition) = $\frac{\text{"O" x tons of cane per 24 hrs. x \% fiber}}{\text{Roll face (inches) x roll speed (FPM) x .1}}$

FIG. 3

Unit Bagasse Roll Openings for
Various m/f ratios



"O" = Total bagasse opening per short ton of cane per 24 hrs. per inch of roll face - per foot of roll speed per minute for cane with 10% fiber.

Actual Openings =

$$\frac{\text{"O" x tons per 24 hrs x \% fiber}}{\text{.1 x roll face (inches) x roll speed (FPM)}}$$

On the other hand, if the cane opening were much too wide, the bagasse arriving at the bagasse roll would be much too wet, and the mill would choke or give very poor results.

There is then an optimum ratio between the cane and bagasse opening, for a given set of conditions. The problem is to determine this ratio.

In actual practice the cane opening is made anywhere from 1-3/4 to 4 times the bagasse opening.

The writer's experience has been that with the bagasse openings determined by eqn. (5) a cane opening of two times the bagasse opening on the first mill to three times on the last mill gives very satisfactory results, the ratio of openings on the intermediate mills increasing uniformly from 2 to 3.

Turnplate Openings

The opening between top roll and turnplate is not susceptible of a logical mathematical solution. The object of the turnplate is to transfer bagasse from the cane roll to the bagasse roll.

If the turnplate is too high, the load from the top roll is too great, wearing out the plate, absorbing horsepower, and constricting passage of bagasse so that it chokes the cane opening and the cane won't feed properly.

If the turnplate is too low, the bagasse passing over it is not compressed enough to prevent the top roll from rolling or folding it over, resulting in a turnplate or bagasse roll choke.

The writer has found, that with average pitch roll grooving, a turnplate opening of 1-1/2 times the cane roll opening gives satisfactory results. This is the opening measured on the vertical centerline of the top roll, from the pitch line of the grooving to the top of the turnplate. A slope of about 1/16" per inch of width of the turnplate is generally used.

A practical and simple method of laying out turnplates is shown in Figure 4. On very coarse pitch roll grooving this procedure results in a considerable rise, or hump, on the turnplate at the cane roll causing restriction of cane flow. In any case, radius "R" should pass within 1/2 or 3/4 of an inch of the root of the cane roll grooving when the arc is extended. If this amount is exceeded the turnplate opening should be increased enough to correct the condition.

Roll Settings

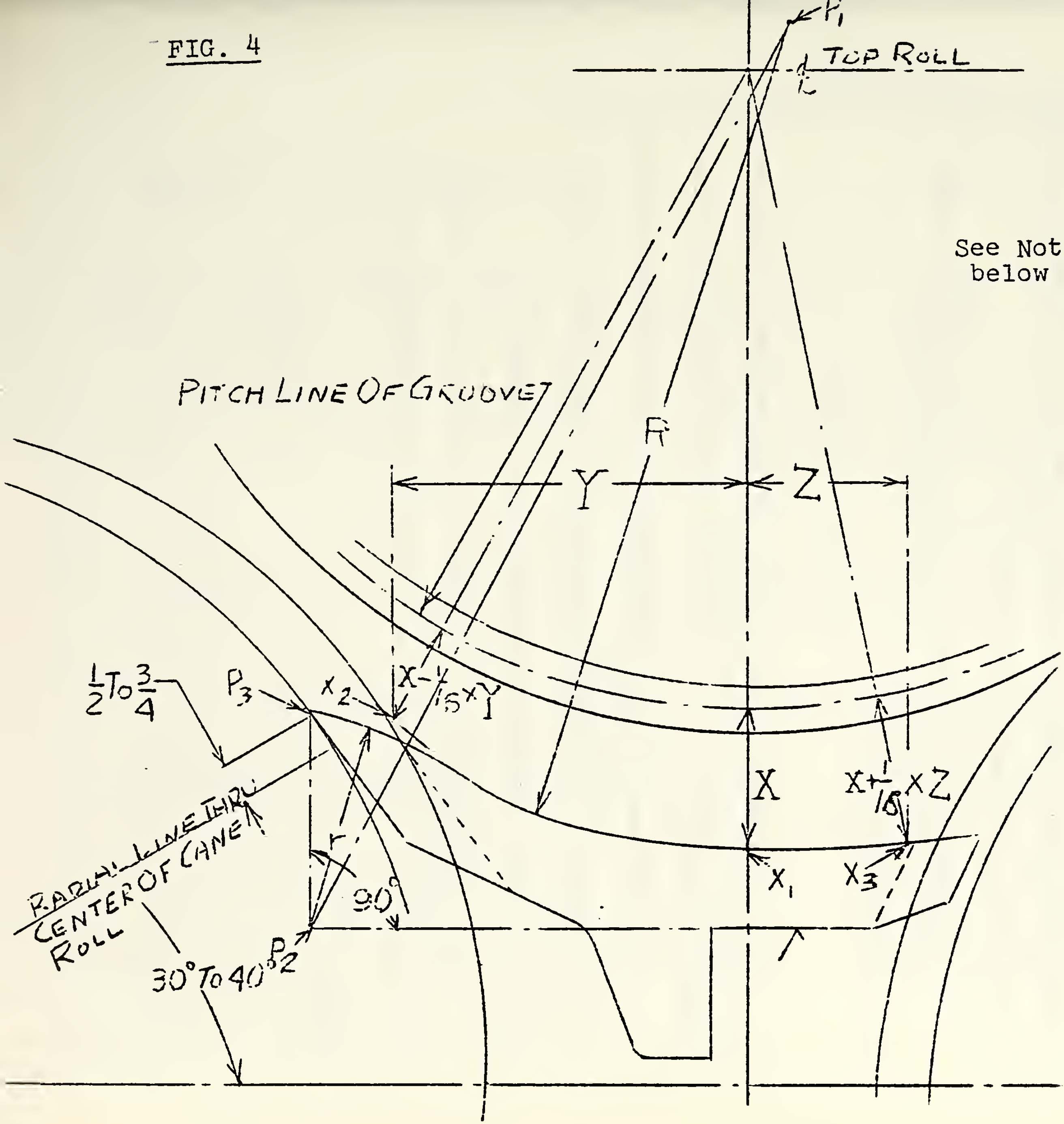
Thus far we have considered openings when grinding as distinguished from roll settings when the mill is at rest.

For settings, the normal desired "roll float" or lift must be taken into consideration. Although 1/4" roll float was most commonly used in the past, 3/8" is becoming more popular since it makes the uniformity of feed less critical.

The change in roll opening is actually slightly less than the actual roll lift. For small roll floats this difference is small and can be ignored. For larger floats the difference should be considered.

The following gives approximate values to be deducted from calculated roll openings in order to obtain roll settings for various assumed roll floats.

FIG. 4



STEPS

1. Calculate roll settings.
2. Layout (full size) rolls and bottom of grooves.
3. Determine X = 1-1/2 times cane roll point to root openings minus roll float.
4. Locate Points x_2 & x_3 (See Note below)
5. Select radius 'R' which will pass thru Points x_1, x_2 and x_3. Mark ctr. for this radius p_1.
6. Locate Point p_2 approx.
7. Strike line from p_1 to p_2.
8. Swing radius "r" from point p_2.
9. If point p_3 falls outside of 1/2" to 3/4" range readjust location of point p_2 and redo steps 7 thru 9.

NOTE: Y & Z dimensions are arbitrary, and merely a means to obtaining turnplate slope of approx. 1/16" per 1". The larger the valve used for locating points x_2 and x_3 the better.

Float	Deduct
1/4	1/4
3/8	5/16
1/2	7/16
3/4	5/8
1	7/8

The preceding theoretical method of arriving at the openings and settings assures that the mill will grind. Constant watch and adjustments will be necessary to get the most from each unit.

Brix diagrams of the juice from each mill (and roll) will be found to give a good check.

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Fig. 5 is a sample work sheet for a typical tandem, showing theoretical openings and settings based on the data presented in this paper.

Numerous such theoretical settings have been compared with actual settings producing satisfactory milling results. The reliability of the data in this paper has been verified in most such cases.

It is strongly felt that this material will be of practical value to mill engineers who are interested in the theoretical aspects of mill settings.

FIG. 5
Typical Work Sheet for Mill Settings

$$\text{Factor} = \frac{\text{Tonnage} \times \text{fiber}}{\text{Face(inches)} \times \text{Speed (FPM)}} \times .1$$

Factor x "O" = Bagasse Opening

Mill Size: 36 x 78
Tonnage: 4300 tons/24 hrs.
Fiber: 14%

Mill No.	M/F	Mill Size	Speed RPM	Speed FPM	R	"O" Chart	Factor	ROLL OPENINGS Bag. Op.	Ratio C/B	Cane Op.	Ratio TP/C	T.P. O.P.
1	67	37x78	4.54	44	7	.840	1.758	1.475	2	2.950	1.5	4.430
2	58	36x78	5.67	53.5	5.7	.556	1.443	.803	2.25	1.810	1.5	2.715
3	53	"	6.10	57.4	5.4	.425	1.346	.572	2.5	1.430	1.5	2.150
4	50	"	5.6	52.9	5.8	.362	1.46	.528	2.75	1.450	1.5	2.175
5	48	"	6	56.6	5.6	.337	1.363	.459	3	1.380	1.5	2.070

Mill No.	ROLL SETTINGS 3/8" ROLL FLOAT			ROLL SETTINGS ADJUSTED		
	BAG.	CANE	T.P.	BAG.	CANE	T.P.
1	1.163	2.638	4.055	1-3/16	2-5/8	4-1/16
2	.491	1.498	2.340	1/2	1-1/2	2-3/8
3	.260	1.110	1.775	1/4	1-1/8	1-3/4
4	.216	1.130	1.800	7/32	1-1/8	1-13/16
5	.147	1.068	1.695	5/32	1-1/16	1-11/16

"O" = Bagasse roll opening for One short ton of cane at 10% fiber, per inch of roll face, per one ft/min. roll speed.

Roll Openings and settings are point to root.

T.P. Openings and settings are pitch line top roll to top of T.P.

MUD FILTRATION THROUGH THE FAS-FLO FILTER

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The handling of clarifier muds has always been a troublesome thing to sugar factory operators. When continuous clarifiers came into general use, the mud was usually filtered through plate and frame presses. The procedure was a reasonably good one with the resulting juice being clear so it could be sent directly to the evaporators along with the clarified juice.

The operation of the presses was quite another thing, however. Considerable labor was required and the expense of cloths - washing, repair, and replacement - was quite high. The advent of the rotary vacuum filters was very welcome, therefore, and as is well known, such filters are now standard equipment in most sugar factories throughout the world.

Vacuum filters brought with them the end of the high labor and cloth cost which went with plate and frame presses. But with this great benefit came what have been increasingly recognized as problems worse than those of plate and frame presses. The vacuum filters were not really filters at all. While they removed considerable mud from the factory, they did not produce a filtrate which was clear. One of the effluent ports of the vacuum filter is intended to produce a cloudy filtrate since it is at this portion of the rotation of the drum that the cake is being formed; the other port is then supposed to deliver a clear filtrate. It is well-known by sugar factory operators that both ports deliver juices which are very dirty and which must be returned to the beginning of the process. This recirculation has resulted in a requirement of 20 to 25 per cent additional clarifier capacity. It is obvious that recirculating such a large amount of juice and keeping it under high heat for several unnecessary hours results in inversion losses. It is also a known fact that the recirculated mud particles are very unstable and quickly decompose--meaning additional inversion.

And, to the dismay of operators in areas of high ratio of mud to cane such as Louisiana, the recirculation causes much more damage than just inversion losses. A substantial part of the continually recirculating fine suspended solids passed by the vacuum filters remain in the system and increase each day, reducing the output of the clarifier; when rain comes and additional mud is brought to the factory with the cane, it is not unusual for the factory to reduce its grinding rate considerably in an attempt to keep the mud level low in the clarifiers and produce an acceptable clarified juice. In other words, all the mud is not being removed from the factory by the vacuum filters, although complete mud removal is their purpose.

A paper on this subject was presented before this body a few years ago by Mr. H. J. Jacobs of the South Coast Corporation. In this paper Mr. Jacobs reviewed much of the foregoing and discussed the reasoning behind the decision of his company to abandon the use of vacuum filters and replace them with plate and frame presses. This paper brought home to many the fact there has been no filter other than a plate and frame press which could effectively filter clarifier mud through cloth and produce a clear juice for the evaporators, removing all mud from the factory.

Accordingly work was begun in 1954 in Louisiana with what was then a new pressure filter--the FAS-FLO Filter. A Fas-Flo was installed at the Southdown factory to determine two things: first, could such a filter filter the whole mud from the bottom of a clarifier and, second, if it could, would the sluicing system of this filter remove it effectively without leaving cloths blinded which is the case with the cloths on presses? Both questions were answered very quickly in the affirmative. The mud filtered readily without the addition of any bagacillo or other filter-aid and a brilliant juice resulted. The cloths were very clean after each cycle, indicating the effectiveness of the sluicing system.

The fact that the cloths were cleaned so well is the reason that this filter is practical for this service while other pressure filters are not. It might be wise to describe the filter at this point so that the reader can understand a little more readily how it works.

The Fas-Flo Filter consists of a vertical cylindrical tank inside of which are the filter elements. These are cast aluminum leaves, arranged horizontally, one above the other and resting on a steel framework. The filter leaves are semicircular, with two such sections on each level. Each leaf section has its own outlet, through the shell of the filter, discharging its filtrate through a sight glass and shut-off valve before connecting to a common manifold which delivers the filtrate to the desired station - in this case, the evaporators.

The leaves filter on their top surfaces only; the cake builds on this surface, then, and because of the horizontal arrangement of the leaves, it cannot fall off if there is a momentary interruption in the feed or a pressure change. This is an important point since, if the cake were to be disturbed, the leaf would run cloudy. Also if at the end of a cycle the cake were to fall, it is obvious that effective sweetening off could not occur.

The sluicing mechanism consists of a main sluice header running vertically through the center of the filter between the semi-circular leaf sections. From this vertical header there are smaller pipes - or "arms" - extending horizontally over each leaf. There is one such arm for each leaf level. Each arm is equipped with four nozzles which form a fan-shaped spray, each spray overlapping each other spray and reaching all sections of the leaf surface. The main sluice header, along with its arms, is rotated by means of a small fractional horsepower motor. High pressure water is admitted to the sluice system and as the apparatus revolves slowly, the fan-shaped sprays blast away the cake; when the cake is removed the sprays, which strike almost vertically, continue their work, actually cleaning out the pores of the cloths and driving any remaining mud particles through the cloth to the ditch.

It is this action which has proven to be the reason that the Fas-Flo Filter has been successful on mud filtration while other pressure filters have not. The cloths in this filter do not blind from use as is the case with plate and frame presses or pressure filters which are sluiced by means of jets of water which work parallel to the leaf surface. The cloths in this filter eventually must be replaced, not because they are blinded and thus slow production, but because they are physically worn by the water jets. The life of a set of cloths is from 4 months up, depending on the service.

As is generally known, the Fas-Flo Filter was developed originally for refinery service and, as mentioned above, was tried on mud filtration service after it was perfected for refinery operation. It might be asked if the mud filter differs from the refinery filter; it does, but only in a very minor way. The refinery filters, for the most part, have leaves spaced on 3" centers, allowing for a cake thickness of about one inch; the mud filters are made with leaves on 3-1/2" centers, allowing a cake thickness of one and one-half inches. The reason for the greater cake capacity is that the proportion of suspended solids in the mud is much greater than is the case with refinery liquors. In about one hour and twenty minutes the Fas-Flo with 3-1/2" spacing is filled to capacity with mud, indicating its effectiveness for actually removing mud from the factory. It follows that a refinery filter would not be used for whole mud filtration because the cycle length would be too short for efficient operation.

There is one factory in the world now using Fas-Flo Filters exclusively for mud filtration. The factory is known as Ingenio Villanueva, located in Honduras. Villanueva is a new factory, having just completed its second crop. Operations started in early 1959. There is no provision for handling muds other than the Fas-Flo Filters.

The cane is all hand cut and hand loaded on trucks for transport to the factory. No burned cane is accepted by the factory. The factory produces a direct consumption sugar, the mixed juice being treated with lime and sulphur and, in this recent crop, with Separan. This flocullating agent is fed at the inlet to the clarifier, at a dosage of about .4 pounds per ton of cane. The clarifier is a three tray, twenty foot diameter unit.

The flow chart illustrates the operation of the mud filters.

The mud is pumped directly from the bottom of the clarifier to a receiving tank from which the filters are fed. Some lime can be added at this point should a correction in pH be advisable. (Of course the filtrate from the Fas-Flo must have the same pH as the clarified juice so as to avoid any precipitation in the evaporators.) Repeated checks during the crop at Villanueva showed no difference in the pH of the two juices.

The mud is pumped to the Fas-Flo with no further treatment. It is to be emphasized that no bagacillo or other filter-aid is added. The mud itself contains sufficient natural filter-aid to give body to the cake and permit continuing filtration. As a matter of fact the first juice to be filtered at the beginning of the cycle comes perfectly clear and the filtrate outlet pipe which can direct the filtrate back to the pump tank in the event of a momentary cloudy condition, has never been moved from the position which directs the filtrate to the evaporators. The juice coming from the filter is brilliant, better than clarified juice, and contains no visible suspended solids.

The average filtering time at Villanueva was one hour and twenty minutes. At the end of this time a cake thickness of approximately 1-1/2" was built up. At this point the filter was drained to the drainback tank and this mud picked up by the other filter which was been cleaned, ready for a new cycle. The first filter then was sweetened off by means of compressed air and steam blowing the remaining juice through the cake to the clarifier. Following sweetening off the filter was sluiced.

The typical cycle at Villanueva lasted two hours and ten minutes, of which, as mentioned above, one hour and twenty minutes were actually filtering time; the balance is "down time" and is consumed by filling, draining, sweetening off, and sluicing. This down time is considerably longer than is normally required but, since the filters at Villanueva were frequently forced to wait for mud because they ran ahead of the clarifiers, there was no real need to reduce the downtime. A filter can be back on the line in about thirty minutes.

One of the important questions which was answered at the Villanueva factory was that of capacity of the Fas-Flo Filter. The actual filtration of mud was proven to be possible by the experience at Southdown but because only a small filter was used there and because there were two vacuum filters in operation it was not possible to estimate the number of square feet of filter area necessary per ton of cane ground except in a very rough way. At Villanueva accurate data was gathered. Of course, the grinding rate of a factory is the simplest yardstick to use when determining its general size and production capacity. But such a measurement alone should not be used estimating the size or number of Fas-Flo Filters required for, as is perfectly obvious, the amount of mud varies quite widely from country to country and, indeed, from factory to factory even within a fairly small area.

The only practical method is to know in advance the amount of mud per ton of cane ground. This is a figure which very few people know or can be sure of. It is estimated by many factories today by taking spot samples from a given area on the drum of a vacuum filter but at best this can be a rough figure; it was a very accurate figure in the days of a plate and frame press because at regular intervals it was customary to remove one complete frame, note the net weight of the mud itself and then keep a record of the number of presses cut down each day.

A similar method was followed at Villanueva. Full leaf sections were removed from the filter with mud still on them. This was done several times and an average was obtained. It is thus known how much mud was removed by the Fas-Flo Filter each cycle; the number of cycles was recorded and compared to tons of cane ground in the same period. A summary of the data gathered is shown in a table at the end of this paper.

The total weight of mud removed by a Fas-Flo each cycle at Villanueva was 5,292 pounds. If there are 11 cycles per day it will be seen that 58,212 pounds of mud are removed per day. The capacity of one 540 sq. ft. Fas-Flo is thus computed as follows:

With 2% mud (40 lbs. per ton of cane): 1450 tons of cane per 24 hours
With 2-1/2% mud (50 lbs. per ton of cane); 1160 tons of cane per 24 hours
With 3% mud (60 lbs. per ton of cane); 970 tons of cane per 24 hours
With 4% mud (80 lbs. per ton of cane); 725 tons of cane per 24 hours.

The question of sweetening off the cake after the filtration cycle is over is one of great interest. The cake at Villanueva was sweetened off by blowing it down with a combination of compressed air and steam. The average sucrose level in the cake for the recent crop at Villanueva was 5.8%. There was practically no dilution.

There are two schools of thought on the degree of sweetening off of mud which should be done. One view is that the sucrose level should be as low as possible while the other is that to reduce the sucrose level too far results in redissolving impurities causing more molasses and requiring more fuel to evaporate the dilution.

As filter manufacturers we prefer to stay neutral because the problem is a complex one involving the price of sugar, molasses and the cost of fuel, all of which factors are the direct concern of the sugar factory management.

If complete sweetening off is desired in a Fas-Flo it can be quickly accomplished by filling the filter with water, passing it through the mud cake and, when the brix is reduced to a satisfactory level, draining the water in the filter to a holding tank for use in the next cycle. A refinery filter cake is sweetened off from 65°Brix to minus 5°Brix (zero corrected) in less than ten minutes so a cane mud cake of say, 15° Brix, would be sweetened off very rapidly.

On comparing the normal methods of handling muds, one can see the following advantages of the Fas-Flo Filter. With vacuum filtration around 15% of the total juice is recirculated through the clarifier. At Villanueva there is absolutely no recirculation and the clarifier capacity is therefore increased. Inversion losses caused by the recirculation of fine suspended matter is eliminated completely since all of the filtrate from the Fas-Flo is clear and goes directly to the evaporators. In other words, the effective filtration of muds which is known to be had with filter presses can now be accomplished with a pressure filter but with the advantages of a cleaner and cooler mud station and a much lower cloth and labor expense.

INGENIO VILLANUEVA

SAN PEDRO SULA HONDRUAS

SUMMARY OF DATA

	1	2	3	4	5	6	7	8
DATE	GRINDING TIME	TONS OF CANE	TOTAL FILTERING CYCLES	TOTAL LBS. OF MUD REMOVED	LBS. OF MUD REMOVED PER TON OF CANE	% POL. IN MUD	TOTAL POL. IN MUD REMOVED-LBS.	% MOISTURE
Feb.18	24 Hr.	680	13	68,796	101.1	-	3,990	-
Feb.19	20.75 Hr.	590	11	58,212	98.6	6.2	3,376	70
Feb.20	20.75 Hr.	585	9	47,628	81.4	5.8	2,762	73
Feb.21	23.5 Hr.	690	15	79,380	115.0	5.4	4,604	73
Feb.22	24 Hr.	685	8	42,336	61.8	5.9	2,455	70
						Av. 5.8		Av. 71.5%

Col. 4 - Obtained by multiplying total filtering cycles (Col.3) by total weight of cake per filter (5292 lbs.)

Col. 6 - The values shown are the result of spot samples taken from filters during the test and from the mud on the leaves removed from the filters.

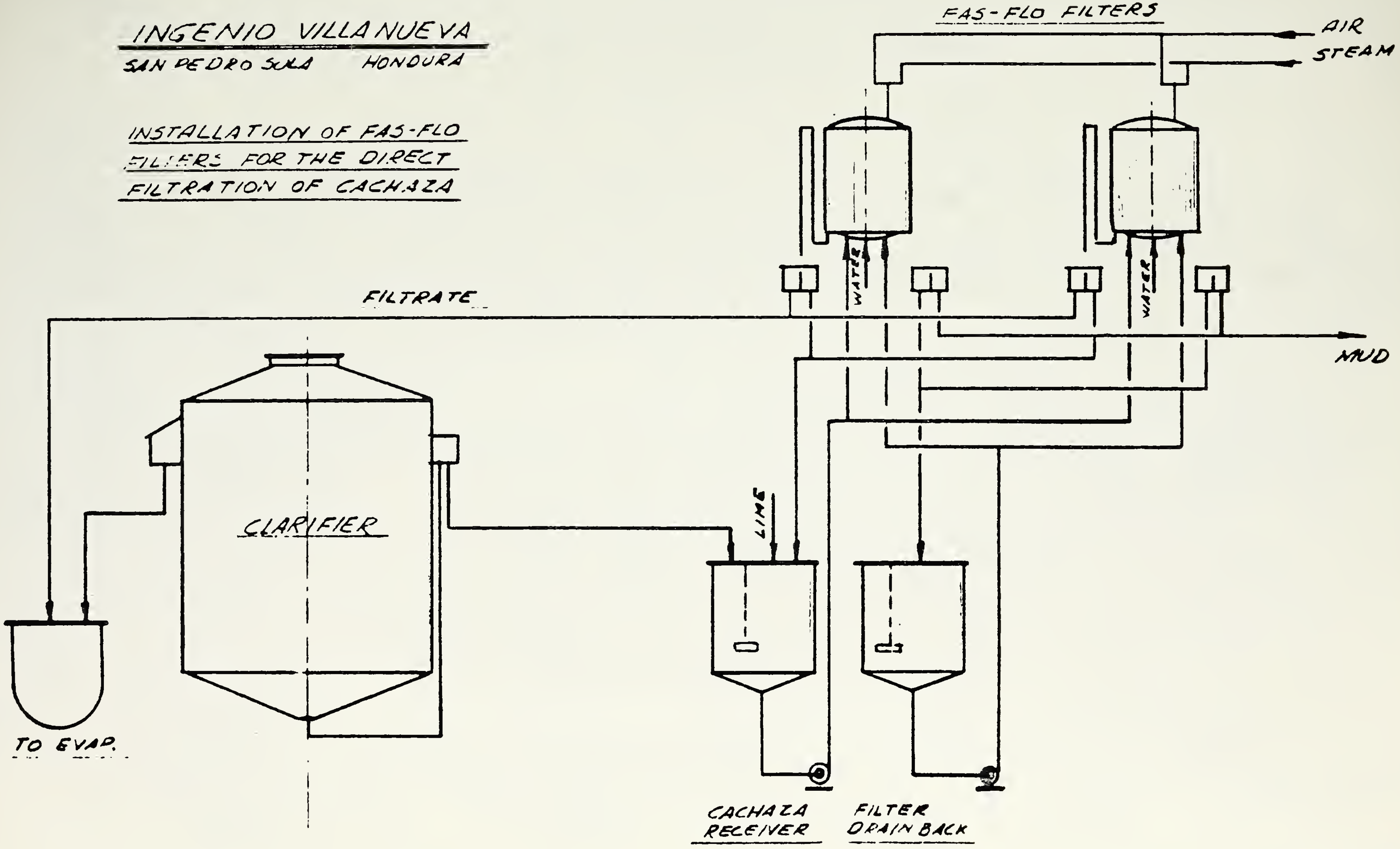
Col. 7 - Represents the result of total mud removed (Col.4) by the average of the percent polarization (Col.6).

Col. 8 - The high moisture shown is presumably due to the use of Separan which gave a fluffy and voluminous cake, but high flow rates, compared to the first crop when phosphoric acid was added which caused a gummy, poor filtering cake. In the first crop, the moisture was 65%.

INGENIO VILLANUEVA

SAN PEDRO SULA HONDURA

INSTALLATION OF FAS-FLO
FILTERS FOR THE DIRECT
FILTRATION OF CACHAZA



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PROCEEDINGS

American Society of Sugar Cane Technologists

Volume 8 — Papers for 1961

◆

February, 1962

LOUISIANA STATE

PROCEEDINGS

American Society of Sugar Cane Technologists

Volume 8 — Papers for 1961

February, 1962

FOREWORD

This is the eighth volume of proceedings of the Society which have been published since its founding in 1938.

The first volume published in 1941 included papers presented during 1938, 1939 and 1940. Mr. Walter Godchaux, Jr., the then Secretary - Treasurer edited that edition.

The second volume published in 1946 included papers presented during 1946-1950 inclusive. The fourth volume included papers presented during 1951, 1952 and 1953. The fifth volume included papers presented during 1954 and 1955. The sixth volume included papers presented during 1956. The last five volumes were edited by Dr. Arthur G. Keller.

The seventh volume which includes papers for the years 1957-60 will be published during 1962. This eighth volume has been compiled by the writer. Plans for subsequent volumes of proceedings of the Society are to be on an annual basis.

Denver T. Loupe

Secretary-Treasurer

February 1962

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SOILS OF THE SUGARCANE AREA IN LOUISIANA

Charles C. Cain, Professor of Agronomy
University of Southwestern Louisiana

We have been dependent on soils for the production of most of our food in the past and will continue to be dependent on soils in the immediate future even though there are predictions of other methods of production. Although farmers in the U. S. are presently producing a surplus of some foods and fiber, the rate of population increase is such that some authorities foresee serious shortages due to limited soil resources.

Increased efficiency in farm operations has been phenomenal in this country and improved techniques in using the soil have been a part of this overall increase in efficiency. With rising land values it has become necessary to produce even more efficiently on each acre in order to justify the investment in land.

It is necessary that we study and classify soils in order to learn the relationships among the different kinds of soil, the best uses of these different kinds of soils, and the soil needs. This program of classifying soils on a national scale was undertaken approximately sixty years ago and is continuing on an accelerated basis since World War II. The soil survey bulletins of St. Mary Parish and Terrebonne Parish have been issued in the past two years and are of great value in planning proper use of the soils in these areas.

The area in Louisiana where sugarcane is grown for sugar is restricted by the length of the growing season on the north and by soil characteristics on the east, west and south. The shorter growing season limits this area so that the northern boundary extends only into

Rapides and Avoyelles Parishes. Restricted internal drainage and low fertility level of the coastal prairie and coastal plain soils limits the sugarcane area on the east and west, and restricted drainage of the soils along the coastal marsh limits the southern boundary of this crop.

Soil, as we use the term here, is the collection of natural bodies on the earth's surface, containing living matter, and supporting or capable of supporting plants. The characteristics or properties of the soil are determined by the interaction of climate, living organisms, and relief acting on the parent material over a period of time.

It is believed that the difference in climate throughout the sugarcane belt has been insufficient to cause major differences in the soils. The natural vegetation that has existed ranges from forest to prairie to marsh type plants and accounts for some of the variations in organic matter content and leaching of the soils.

Relief and drainage have played an important role in determining the soil characteristics in South Louisiana. The relief ranges from depression areas in the old stream channels to strongly sloping where the loessial terrace joins the alluvial plain. Internal drainage ranges from the water-logged swamp and marsh soils to the moderately well drained soils of the terraces.

The parent materials from which these soils are developing were deposited by the Mississippi River and the Red River over a period of thousands of years. The texture of these deposits range from sandy near the channels to clay in the backswamp basins and silt on the Pleistocene terraces. The age or time that these materials have been undergoing weathering at their present sites range from some thirty thousand years for the Pleistocene terraces to materials that are still accumulating in the coastal marsh.

Thus the three most important factors contributing to soil characteristics in South Louisiana are nature of parent material, age or stage of weathering and drainage or relief.

The Pleistocene terrace soils are developed from silty deposits washed from other terraces or loessial uplands some thirty thousand years ago. This area forms the eastern and western boundaries of the recent alluvial deposits which make up the largest portion of the area in which sugarcane is grown for sugar. The soils of this terrace are the most highly weathered and leached soils of the sugarcane belt. Within the area of recent alluvium are areas of low stream terrace deposits along the present channels or old stream channels which have been undergoing weathering for 2000 to 5000 years. Some areas of the recent alluvial deposits are still receiving additional sediments, particularly along the coastal marsh. Thus we see that there is considerable variation in the stage of weathering and soil development for the soils of the sugarcane area and this helps to explain some of the differences in response to mineral fertilizers.

The soils on the Pleistocene terraces have undergone more weathering and leaching than any other soils in the area so it is not surprising that yields are somewhat lower on these soils and response to applied phosphorus and potassium is more consistent. These soils vary from moderately well drained Lintonia series on gentle slopes to the somewhat poorly drained Olivier series on the level areas. Much of the Lintonia on the sloping areas has been retired from cultivation due to excessive erosion. Experiment station fertilizer recommendations are 60 to 80 pounds of nitrogen per acre on plant cane and 80 to 120 pounds of nitrogen, 40 pounds of P_2O_5 and 40 to 80 pounds of K_2O per acre on stubble cane.

The soils on the low terraces or natural levees along Bayou Teche have weathered in place for 2000 to 5000 years and have undergone moderate leaching, especially the coarser material on the highest part of the natural levee. These soils range from the moderately well drained Cypremort series developing on the gentle slopes to the poorly drained Baldwin series on the level areas and the very dark colored Jeanerette and Iberia series which occur on level or depressed areas and are somewhat poorly drained to very poorly drained. Sugarcane yields are usually higher on these soils than on the loessial terrace soils and response to mineral fertilizers has been good. The experiment station fertilizer recommendations are the same as for the loessial terrace soils.

The recent alluvial soils of the Mississippi River flood-plain have been weathering in place for a relatively short period of time and have very little profile development. These soils vary from the moderately well-drained commerce series near the channels to the somewhat poorly drained Mhoon series and poorly drained to very poorly drained Sharkey and Alligator series. Sugarcane yields on the commerce and Mhoon series are very good however response to phosphorus and potassium fertilizers has not been consistent. Fertilizer recommendations of the experiment station are 80 pounds of nitrogen per acre on plant cane and 80 to 120 pounds per acre on stubble cane. Phosphorus and potassium should be used where soil tests show there is a need.

The recent alluvial soils of the Red River floodplain have very little profile development and vary from the well-drained Yahola series to the imperfectly drained Miller, Portland and Buxin series and the very poorly drained Perry series. Experiment station recommendations are the same on these soils as on the recent alluvial soils of the Mississippi River.

The moderately well drained soils are used mainly for row crops except the areas that have been retired to pasture due to erosion. Included in these soils are the Lintonia and Richland on the Pleistocene loessial terrace, the Cypremort soils on the more recent terrace and the commerce and Yahola soils of the Mississippi and Red River floodplains. The somewhat poorly drained soils are frequently used for row crops with success where surface water can be removed promptly. Included in these soils are the Olivier soils on the Pleistocene terrace, the Jeanerette, Iberia, Baldwin, Patoutville soils on the more recent terrace and the Buxin, Portland, Miller and Mhoon on the Red and Mississippi River floodplains. Sugarcane yields on these soils, except on the older Olivier soils, frequently are higher than for the other soils in the area if adequate surface drainage is provided.

On the very poorly drained soils row crops are sometimes grown with varying success. Included in these soils are the Iberia clay and Baldwin, low phase soils of the more recent terrace and the Sharkey clay, Alligator and Perry soils of the Mississippi and Red River floodplains. During seasons of good rainfall distribution satisfactory crops are made if proper surface drainage is provided and high rows are used. Much of this area could properly be devoted to pasture or rice.

In summary I should like to say that our soil problems in the sugarcane area are not solved nor are there simple solutions available. A great deal of work has been done by the L.S.U. Experiment Station on the chemical and physical properties of the soils in this area under the leadership of Dr. M. B. Sturgis. This work has pointed towards higher yields and as we go higher Dr. L. E. Golden's work seems to point towards more use of phosphate and potash fertilizers on soils that showed little or no response until recently. Some of the older soils are showing possible needs of lime and this will become more pronounced with continued use of large amounts of nitrogen.

You have at your disposal a wealth of material and manpower to go forward with your production. If the information that is currently available to each of you is properly used and the information that is becoming available year by year is used the trend in sugarcane yields should continue upwards for a number of years. As you well know the problems are not limited to the physical conditions of the soil and the use of fertilizers, but include variety improvement, insect, disease and weed control, rotations, mechanical handling, etc.

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THE LOUISIANA SUGARCANE HIGH YIELD RECOGNITION PROGRAM

by

Denver T. Loupe
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L.S.U. Agricultural Extension Service

Unusual achievements deserve recognition; recognition can inspire additional achievements. These two basic ideas became the objectives of the High Yield Recognition Program initiated in 1956 through the joint efforts of the LSU Agricultural Extension Service and the American Sugar Cane League.

Growers who produce high yields as a result of having done an outstandingly good job are recognized annually. In addition publicity is given to the methods they use to produce high yields of sugar cane per acre hoping that other farmers will adopt these successful practices.

For the purpose of offering this recognition, a state program was formulated. The plans under which the present program operates are as follows:

1. The award shall be in recognition of farmers producing the highest yields of sugar cane per acre provided these yields are not less than 20 per cent above the district average.
2. Any producer with five acres or more in sugar cane on a farm in any sugar cane producing parish is eligible.
3. The farmer producing the highest per acre yields of sugar cane (standard tons of sugar cane), provided that these yields are at least 20 per cent above the district average in each of the five size groups will be recognized. There will be a further classification by districts. Thus, a maximum of five farmers (one in each group) in each of the five districts, or a total of 25, will be recognized.

(a) Farm Groups:

Group I - 5 to 49.9 acres
Group II - 50 to 99.9 acres
Group III - 100 to 199.9 acres
Group IV - 200 to 499.9 acres
Group V - 500 acres and above.

(b) Districts:

District I - Vermilion, Lafayette and St. Martin Parishes
District II - St. Mary and Iberia Parishes
District III - Assumption, Lafourche and Terrebonne Parishes
District IV - West Baton Rouge, Ascension, St. James, St. John, St. Charles and Iverville Parishes
District V - Rapides, Avoyelles, Pointe Coupee, West Feliciana and St. Landry Parishes.

4. Yield data will be obtained from the records of the Agricultural Stabilization Committee (A.S.C.).

5. Yields are to be expressed in terms of tons of "Standard Sugar Cane".

6. The recognition or award will be a certificate presented to each farmer producing the highest per acre yield in his respective group and district. The presentation will be made at a state-wide luncheon sponsored by the American Sugar Cane League and the L.S.U. Agricultural Extension Service.

7. Specific details as to type of certificate, luncheon, time and place of presentation will be decided upon by the sponsoring agencies.

8. The county agents in each of the sugar cane producing parishes will be responsible for submitting to the State Extension

Office the names, addresses, yield data and other necessary information.

In addition to the state awards program, most parishes sponsor a similar recognition program on a local level. The local programs have been successful in bringing local agricultural agencies together. Procedures are developed, recommendations made, resulting in a more uniform approach to the total parish sugar cane production program.

The following table presents, in summary form, information regarding recognition to individual growers.

TABLE I

NUMBER OF FARMERS RECEIVING RECOGNITION BY DISTRICTS AND INDICATING NUMBER OF YEARS EACH INDIVIDUAL RECOGNIZED

	Number of years an individual recognized					
District	1	2	3	4	5	Total
I	16	3	0	1	0	26*
II	5	4	2	0	1	24
III	11	5	1	0	0	22
IV	9	1	1	3	0	26*
V	11	3	0	1	0	21
TOTAL	52	16	4	5	1	119**

*Denotes tie (occurred twice)

**Eight (8) groups failed to qualify due to 20 per cent above district average restriction.

During the five years that the program has been in progress, 119 individual certificates have been presented. Of these, 52 were to individuals who have been recognized only once; 16 have been recognized twice; 4 have been recognized three times; 5 have been recognized four times and one individual was recognized for five consecutive years.

This grower, Nicholas Paul of Star Route A, Box 59, Franklin (St. Mary Parish), Louisiana, was presented a special award in 1960. A "Superior Sugar Producer" plaque was established for this outstanding achievement.

It is particularly interesting to study the yields that have been reported. Table II is presented for this purpose.

TABLE II

YIELDS PER ACRE LISTED ACCORDING TO DISTRICTS, AND YEAR GIVING TOTAL AVERAGE YIELDS COMPARED TO AVERAGE YIELDS OF WINNERS

	District Average T/A[1]					District Average Winners T/A[1]				
District	1955	1956	1957	1958	1959	1955	1956	1957	1958	1959
I	*	20.1	15.6	18.5	18.2	28.4	26.9	19.9	25.4	24.3
II	*	21.1	18.9	23.3	23.1	26.8	32.7	24.6	30.7	33.1
III	*	24.3	24.6	25.6	21.4	35.5	36.6	34.2	37.1	30.4
IV	*	26.6	23.2	25.5	21.9	37.0	39.4	33.2	36.7	34.3
V	*	23.2	21.7	21.8	20.8	28.8	38.1	30.0	31.3	27.1
STATE AVERAGE:										
	24.4	23.6	22.0	22.2	20.3	31.0	33.4	25.8	30.9	28.9

*Not available as 20 per cent above district average provision not in effect.

[1] T/A = Tons per acre (Standard Sugar Cane)

It was not until 1957 that a restriction requiring a grower's yields to be 20 per cent above the district average was added to program plans. However, it was in 1956 (1955 crop) that the highest state average yields was recorded, which was 24.4 tons per acre. An average of 33.4 tons per acre was recorded in 1957 (1956 crop) by the winners. This was the highest average yield reported and it was 9.8 tons above the state average.

State average yields have ranged from a low of 20.3 tons in 1960 (1959 crop) to a high of 24.4 in 1956 (1955 crop). The average yield of the winners have ranged from 25.8 tons in 1958 (1957 crop) to a high of 33.4 tons in 1957 (1956 crop). Differences between average yields of winners above the state average have been as follows:

1956 (1955 crop) - 6.6 tons
1957 (1956 crop) - 9.8 tons
1958 (1957 crop) - 3.8 tons
1959 (1958 crop) - 7.7 tons
1960 (1959 crop) - 8.6 tons.

Thus, it can be readily seen that the Louisiana sugar cane industry could be worth from approximately $5,000,000 to $15,000,000 more annually if growers would put into practice those recommendations accepted by the higher producing growers.

Most award winners agree that the following practices have contributed greatly to their individual success:

1. Proper varieties
2. Weed and grass control
3. Land preparation
4. Adequate drainage
5. Timely cultivation
6. Fertilization
7. Insect control.

However, as is often stated, "We try to follow all of the approved recommendations from the Experiment Stations and brought out by the Extension Service." It is a matter of using "common sense" and doing a good job of farming. Good farming requires good management that will "dove-tail" the many approved practices and fit them into a successful program for a specific farm.

Many individual farmers have been recognized for their achievements. Their success story has been told. Others are better farmers today as a result; some because of a little friendly competition some because they have learned something new and many others because recognition inspired greater interest and effort.

THE PRACTICAL CONTROL OF MOSAIC DISEASE IN LOUISIANA

M. L. Shaffer

The South Coast Corporation

Our scientists here in Louisiana have warned us for the past three years of the increase of mosaic disease in sugar cane. They point out that the problem will probably be with us for a number of years and have suggested that growers follow the recommendations for the practical control of this disease.

I appreciate and thank you for the opportunity of appearing before you today so that I might outline to those of you who might not be familiar with what the industry, and we in The South Coast Corporation are doing, in a practical way, on a rather large scale to control this disease. At the offset I would like to point out that for the first time in the history of sugar cane in Louisiana we are extremely fortunate, variety wise, in having a number of commercial varieties; nine in all, and six are resistant or partially resistant to mosaic disease. This fact alone, if we have the will, makes the control of this disease far easier than it has ever been in the past.

First, we will discuss the Industry's approach. A mosaic committee was appointed on 10 September 1959 by your Chairman of the Contact Committee of The American Sugar Cane League to formulate plans for making available to farmers mosaic regued seed cane. This Committee was composed of Drs. E. V. Abbott, S. J. P. Chilton, I. L. Forbes, R. J. Steib, R. D. Breaux, and Messrs. Clifford LeBlanc, Wm. McCollam, Louis Arceneaux, Denver Loupe, Gilbert Durbin, Lloyd Lauden and M. L. Shaffer. The Committee met on 25 January 1960 and plans of procedure were formulated, approved and a mosaic inspection and tolerance Committee consisting of Drs. I. L. Forbes (Chairman), E. V. Abbott, S.J.P. Chilton, R. J. Steib, R. D. Breaux, and Messrs. Clifford

LeBlanc and Lloyd Lauden were appointed to put the plans into operation.

County agents in the sugar belt were contacted by the Committee to determine the desire and the demand of the growers for clean seed cane and upon receipt of this information varieties and acreages to be rogued, cooperators and locations of seed plots were determined. The fields of the Cooperators were inspected by the Committee for initial infection of mosaic and stunting disease on May 2, 6 and 12th and the final inspection in the fall after all rougings were made on September 15 and 19th. Cooperators in this endeavor had the option of retaining if desired, as is customary, 25% of this seed for their own use. The sale of this seed cane was handled by the County Agent in Cooperation with the Committee and sold for $16.00 per ton.

A resume of this work is presented in Table 1.

Table #1

COOPERATOR	PARISH	VARIETY	ACRES IN SPEED PLOT	No. STOOLS OF MOSAIC ROGUED	Percent Infection at Final Inspection MOSAIC	R.S.D.
Milliken & Farwell (Little Texas)	Assumption	NCO 310	10.06	376	0	0
Savoie Farms	Assumption	CP 52-68	4.13	9	Trace	2.0
(Lula)		CP 44-101	2.50	23	0	3.0
Graugnard & Sons	St. James					
(Sidney)		CP 44-101	4.20	35	0	0
		NCO 310	3.80	503	.01	0
Howard Viator	St. Mary	NCO 310	2.50	Trace	0	4.0
(Adeline)		CP 44-101	2.00	0	0	0

A greater number of requests were received than was indicated from the first reports of the County Agents in the early spring. It was, therefore, necessary for the Committee to allocate the seed so that every request could be partially filled. We hope this allocation was to everyone's satisfaction. The disposition of requests will be found in Table 2.

Table #2

PARISH	No. GROWER REQUESTS	TONS REQUESTED	TONS ALLOCATED
Lafourche	21	305	220
St. James	20	106	106
Assumption	17	95	95
St. Mary	6	60	48
Ascension	3	56	35
St. Charles	1	50	37
St. John	4	50	36
Terrebonne	3	29	9
West Baton Rouge	1	75	34
TOTALS	76	826	620

We feel this is an important service, particularly to the smaller growers who are not large enough and who do not have the training or the facilities for roguing and heat treating. We requested the Extension Department of the Louisiana State University to survey the cane growers to determine what quantity of seed will be required for 1961 plantings so that this service may be stepped-up if necessary and these may be found in Table 3.

Table #3

TONS REQUIRED

PARISH	CP 44-101	CP 52-68	NCO 310	TOTAL TONS
Assumption	200	100	200	500
Lafourche	100	100	100	300
Iberville	50	50	50	150
St. Mary	200	150	200	550
Terrebonne	100	25	75	200
St. James	30	50	50	130
TOTALS	680	475	675	1,830

The seed, therefore, required for growers for 1961 is over twice that which was needed in 1960. Roughly 100 acres of the three (3) varieties will have to be inspected and rogued this year. This response on the part of the growers is encouraging and certainly indicates their desire to control these diseases and the importance of this service to the Industry.

Now we will discuss the approach of The South Coast Corporation. The plan selected for controlling mosaic disease on these properties started immediately with the release of NCO 310 in 1954. Knowing this variety was susceptible to both mosaic and stunting disease, all cane obtained was hot air treated and each year since has been treated and rogued. Likewise, upon the release in 1958 of C.P. 52-68, this variety has been treated for stunting disease and rogued for mosaic. We are personally of the opinion that this procedure has aided us considerably during the past few years in preventing a build-up of the disease and holding its spread to a minimum.

Beginning in 1959, when the apparent spread of mosaic, due to a new strain of the virus, in NCO 310 and other varieties throughout the Industry was found to be increasing, all cane of all varieties used for planting was inspected and rogued of mosaic from one to three times before planting. Then upon acquiring the Raceland properties, we were faced with a large acreage of cane heavily infested with mosaic and on the increase adjacent to our Georgia properties. Immediate steps were taken to put into effect the recommended procedures for the practical control of this disease ie:

(1) Eliminate the source of infection as rapidly as possible.

(2) Plant only resistant varieties.

(3) Establish seed plots and rogue for mosaic.

We, therefore, discontinued planting the susceptible NCO 310 and C.P. 52-68 on Raceland and planted only the resistant or partially resistant varieties as CP 44-101, CP 44-155, CP 36-105, CP 36-13, CP 43-47 and CP 47-193. We rogued on Georgia Divison all cane used for seed of these varieties, hauled it and planted it in Raceland. In addition, we planted a sufficiently large acreage of the moderately resistant variety C.P. 36-105 on a part of Mary and New Hope Plantations between the two Lafourche properties as a buffer to prevent, if possible, the rapid spread of the disease from Raceland to Georgia. On all the other properties in Lafourche, Assumption, Terrebonne and St. Mary Parishes, we have put into effect the standard practice of rouging all varieites of cane from one to four times prior to planting.

A mosaic disease survey was made during 1960 on all South Coast properties to determine the degree of mosaic infection. Spot counts were made in 54% of the 16,600 acres of cane and these findings are reported in Table 4.

Table #4

DIVISION	TOTAL ACRES INSPECTED	PER CENT MOSAIC
Ashland	1905	0 - Trace
Georgia - (1) Georgia	2035	0 - 35.0
(2) Raceland	1048	0 - 86.0
Terrebonne	760	0 - Trace
Oaklawn	2330	0 - Trace
Elm Hall	864	0 - Trace
TOTAL	8942	

Roguing for the practical control of mosaic disease is now another established plantation practice on all properties, and once started, we find it becomes rather routine and is not a tedious, expensive and difficult practice. It is my personal belief, and has been for many years, whether we are threatened with a disease problem or not that permanent seed plots which are highly cultivated, systematically inspected and rogued if necessary, highly fertilized and dusted as required for cane borer control, will pay the industry well.

We in the South Coast Corporation hope therefore that be elimination the source of mosaic infection as rapidly as economically possible, by using resistant varieties to the maximum extent, and by establishing and roguing seed plots of all varieites, which was effective in preventing a build-up of the disease several years ago, we will be able to control mosaic and perhaps even in NCO 310 and CP 52-68 on all properties including Raceland until varieties resistant to the new strain are obtained.

NEW ADVANCES IN WEED CONTROL RESEARCH [1]

W. C. Shaw [2]

The native vegetation in most geographical areas in the United States was not very efficient or economical as a source of food for livestock and humans. As the human and livestock population increased, it has been necessary to replace the native vegetation with more productive, more efficient, and more economical plants for food and fiber.

The sequence of events that occurs in plant successions when native vegetation is disturbed or cultivated fields are abandoned is well known. Weeds comprise an early stage of plant successions that terminate with the climax-vegetation characteristic of the area (figure 1.).

One of the basic objectives of agricultural research is to develop more efficient plants, soils, and animals and to manage them at high productivity levels. The fundamentals of plant ecology emphasize that plant successions always occur in the direction of the climax-vegetation rather than toward the growth of more productive economic crop plants.

In our efforts to produce economic crops, we attempt to fully utilize all available scientific technology to balance the vegetation at a highly productive level. The control of weeds is a basic, essential, and important aspect of this fundamental ecological process. The control of weeds in crops is basically an ecological problem.

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[1] An invitational paper presented at the American Society of Sugarcane Technologists Meeting, Baton Rouge, Louisiana, February 16, 1961. A set of 2x2 color slides was used to illustrate this paper.

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Weeds are among the greatest contributors to crop production costs. They compete with crops for water, light, and mineral nutrients. Weeds increase the cost of labor and equipment, reduce the quantity and quality of crop and harbor insects and diseases which damage the crop.

For example, the average cost of all tillage in sugarcane production is estimated at 14 percent of the value of the crop. It is also estimated that at least one-half of the tillage required in producing sugarcane is due to the presence of weeds. This means that our farmers are losing seven percent of the value of their crop each year due to the increased tillage required to control weeds. To this amount must be added an additional loss of 10 percent due to reduced yields, lowered quality, and weed control costs. It is estimated that the total loss in sugarcane production due to weeds exceeds 40 million dollars each year (10). The single most important objective of fundamental and applied weed control research is to reduce these annual weed losses in crops.

The importance of fundamental science in contributing to our well being has been illustrated many times. Basic research in the field of physics and chemistry led to the development of atomic energy. The sulpha drugs, penicillin, and the other antibiotics are the products of fundamental research in medical science, Selective weed killers resulted from fundamental research in the plant sciences.

Our agricultural progress has been characterized by the discovery, development, and utilization of various forms of energy. Progress in weed control has also been closely associated with the development and utilization of human, mechanical and chemical energy. Our early weed control practices were hand methods, utilizing human energy. Hand methods were later gradually reduced and partially replaced by hand-hoes and other hand tools. Additional progress was made in weed control as a result of the discovery of automotive power. This advancement made it possible to use tractors for more efficient weed control through better tillage and cultivation practices. These developments represented a gradual but steady increase in the mechanization of weed control practices in crop production.

Advances in Fundamental Principles in Weed Control

Important advances have been made in cultural, mechanical, and biological methods of weed control. Research and farm practice have shown that the greatest weed control efficiency results when combination methods are used. There are no substitutes for proper cultural, mechanical, and biological methods of controlling weeds in crop production. Nevertheless, the progress in chemical weed control during the past 10 years has been almost fantastic. Within this brief period many new chemicals and new weed control techniques were developed. These developments were highlighted by the discovery of the herbicidal properties of the phenoxy compounds; the introduction of pre-emergence weed control; the development of low-pressure, low-gallonage application techniques; the development of pre-planting chemical methods of control; the discovery of the role plants play in changing the structure, activity, and selectivity of herbicides; discovery of the effects surfactants, solvents, carriers and other additives have on the selectivity persistence, and fate of foliar and soil-applied herbicides and the development of subsurface herbicide application techniques, soil-incorporation methods, and granular formulations of herbicides.

Herbicide Evaluation Research

The screening, evaluation, and development of new herbicides in the past 10 years have occurred at a rate which has almost exceeded the imagination. Significant progress has been made in developing and standardizing herbicide screening and evaluation techniques. Present methods of herbicide evaluation include the application of new chemicals as pre-planting soil incorporated, pre-emergence, and post-emergence treatments. Advances in experimental application equipment for utilizing extremely small quantities of experimental chemicals and the standardization of evaluation techniques gave impetus to the industrial discovery and development of new herbicides. The development of logarithmic application techniques is an outstanding example of designing a research tool to evaluate more accurately, efficiently, and rapidly the herbicidal properties of new chemicals.

The present tendency is to use a greater variety of herbicide and to use specific ones for the control of specific weeds in specific crops and special areas. The present farmer demands of a new herbicide necessitate that careful consideration be given to all factors affecting its specificity and selectivity. The rate of development and some of the trends in the development of new herbicides offer almost unlimited potential for the selective control of weeds in almost any weed-crop situation.

An almost inexhaustible supply of chemical energy for the selective and non-selective control of weeds in a wide variety of weed-crop situations and specialized areas is provided by the substituted phenoxyacetic, phenoxypropionic, and phenoxybutyric acids; the substituted, benzoic acids, phenylacetic acids, phenols N-phenylcarbamates, thiocarbamates, N-phenylureas, s-triazines; such herbicides as N-1-naphthylphthalamic acid (NPA), 2,2-dichloropropionic acid (dalapon), 3-amino-1,2,4,-triazole (amitrole), 2-chloro-N,N-diallylacetamide (CDAA), 2-chloroallyl diethyldithiocarbanate (CDEC), and others.

New herbicides with great potential for weed control in a wide variety of situations continue to be introduced at a rate unexcelled in the history of the chemical industry. The established herbicides plus such new chemicals as ethyl N,N-di-n-propylthiolcarbamate (EPTC), 3-amino -2,5-dichlorobenzoic acid (amiben), 4-chloro-2-butynyl N-(3-chlorophenyl) carbamate (bar-ban), O-2,4-dichlorophenyl-6-methyl isopropylphosphoroamidothioate 3, 4-dichloropropionanilide, dimethyl ester of 2,3,5,6-tetrachloroterephthalic acid, 2,6-dichlorobenzonitrile, the chlorophenyl amides, and s-triazines have provided great flexibility in achieving selective weed control in terrestrial and aquatic environments. A large share of the credit for these outstanding developments is due to an efficient, forward thinking, chemical industry working in close cooperation with Federal and state research agencies.

Penetration, Absorption, and Translocation Studies

Numerous factors influence the penetration, absorption and the translocation of herbicides. Plant form, leaf shape, leaf position, leaf density, leaf surface, and leaf margins greatly influence the foliar distribution, retention, and uptake of herbicides (figure 2).

Plants that have erect, spreading, or prostrate habits of growth with broad, large, narrow, and short or linear leaf shapes greatly influence herbicide recipient, distribution, and retention patterns. Plants with upright, horizontal, or pendulous leaves which form foliage canopies of various densities markedly influence the retention and uptake of herbicides.

The nature of the leaf surface is critically important. Leaves with waxy, hairy, or variously sculptured leaf surfaces differentially retain and absorb herbicides. Stomate distribution and the nature of the cuticle influence the quantity of material that penetrates the outer layers of the leaf. The permeability barriers of the cell membranes may further decrease the amount of chemical absorbed in the individual cells.

The form, shape, size, density, distribution, and other characteristics of roots in relation of soil-applied herbicides also partially determine the amount herbicide that actually comes in contact with the plant.

The use of radioactive isotopes, gas chromatography, and other modern techniques, is making it possible to obtain an improved understanding of the uptake and movement of herbicides in plants. Once the herbicide has been absorbed by the plant it may be imobilized in the treated tissue by absorption to or conjugation with cell constituents. When certain herbicides are absorbed, the molecules are probably metabolized prior to translocation. Since foliar-applied herbicides move downward primarily in the phloem (living tissue) and soil-applied herbicides upward mainly in the xylem (non-living tissues), all factors which influence plant growth and the transport of inorganic and organic solutes, and water and mineral elements also affect the movement of herbicides in plants (figure 3).

The movement of herbicides in plants occurs in different tissues at different times at different rates. The differential absorption and translocation of herbicides in different species often account for their selective action. For example, the intercalary meristem of certain grasses restricts the translocation of foliar-applied herbicides. Certain translocation barriers also exist in perennial herbaceous and woody plants.

The mechanisms, energy concepts, and interrelationships of the translocation of herbicides in plants are not sufficiently understood for their most effective use. However, the development of new techniques for studying translocation and our present knowledge of herbicide movements in plants indicate that certain translocation obstacles prevent herbicides from reaching their sites of action in the cell in sufficient quantity to control plant growth. These same obstacles also influence and often determine the differential selectivity of herbicides. As we gain a fundamental understanding of the absorption and translocation of herbicides in plants, it will be possible to utilize more efficiently this knowledge for the development of highly selective chemicals.

Fundamental research on the penetration, absorption, and translocation of herbicides in plants has led to the development of new concepts regarding their formulation. In the early development of herbicides, primary emphasis was given the chemical and physical properties of adjuvants that would preserve the herbicide in the container during shipment and enhance application with spray equipment. However, in recent investigations increased emphasis has been given to the influence of surfactants, co-solvents, and other adjuvants on the selective action of herbicides on crop plants and weeds. It has been shown that surfactants may enhance the activity of a herbicide on one crop without increasing the activity of the same herbicide on other crops (7). The results of these studies indicate that it will be essential to select surfactants and other formulating agents on the basis not only of the physical properties the surfactant contributes to the final formulation but also of the role the surfactant plays in the differential activity and selectivity of herbicides on crops and weeds.

Recent investigations showed that surfactant carriers, co-solvents, and other adjuvants in herbicide formulations caused significant effects on the initial and residual activity of soil-applied herbicides (3). In these studies, EPTC formulated and applied in kerosene was less persistent in soils than when acetone was used as a carrier.

These and other studies conducted recently on the role of surfactants, carriers, co-solvents, and other adjuvants on the action of foliar-and soil applied herbicides suggest that formulation constituents can be used to tailor-make herbicides for use in specific weed-crop situations. This fundamental knowledge adds to the growing arsenal of information that can be used in developing selective chemical methods of controlling weeds.

Sites and Mechanisms of Herbicidal Actions

Herbicides modify and control plant growth by inhibiting essential physiological processes or by preventing the biosynthesis of metabolites essential to plant growth. An over simplified version of cellular metabolism is illustrated in figure 4. Some herbicides are known to kill weeds by inhibiting photosynthesis and essentially causing the cell to starve to death (5,12). Others may eliminate many of the biosynthetic reactions of the cell. Many herbicides inhibit enzymes that catalyze specific reactions. If inhibitions occur in a metabolic pathway, the plant may not be damaged if the growth factors blocked can be synthesized through other pathways. However, if a herbicide causes a metabolic block in specific pathways and the essential growth factors cannot be synthesized through other pathways, then growth becomes limiting and the plants may be killed.

While metabolism and biochemical syntheses of growth factors in plants undoubtedly play a significant role in the action of herbicides, the growth controlling properties of herbicides are not necessarily limited to biochemical actions. Physical or chemical effects on cell membranes, spindle fibers, or other subcellular structures may disrupt normal physiological processes of these highly organized cellular components. Most herbicides are known to inhibit many biochemical or physiological processes. Control of plant growth with herbicides undoubtedly results from the accumulative effects of these many biochemical, metabolic, physiological, and physical inhibitions.

No attempt will be made to review the results of investigations on the mechanisms and sites of herbicides, but a few examples will be discussed to illustrate the significant advances that have resulted from fundamental investigations on sites and mechanisms of action of herbicides.

In 1904, beta-phenylpropionic acid fed to dogs was converted in their bodies to benzoyl glycine, a chemical with a different structure and different chemical and physical properties from that originally fed to the animals (9). This achievement was of great interest to plant scientists, but it was 1947 before they demonstrated that plants could also change the structure and activity of chemicals and that nonphytotoxic chemical could be metabolized within plants to phytotoxic compounds(16). This important scientific break through resulted in new concepts on the selective action of herbicides (17). In 1954 it was shown that certain plants could metabolize the herbicidally inactive 4-(2,4-dichlorophenoxy) butyric acid (4-2,4-DB) through the process of beta-oxidation to the herbicidally active 2,4-dichlorophenoxyacetic acid (2,4-D). Therefore, weeds and crop plants capable of beta-oxidizing 4-(2,4-DB) to 2,4-D were killed, whereas plants not capable of beta-oxidizing 4-(2,4-DB) to 2,4-D were tolerant to the inactive 4-(2,4-DB) and were not killed (17.) The highly selective herbicide 4-(2,4-DB) was developed directly as a result of these investigations. This herbicide has shown excellent promise for the post-emergence control of broadleaved weeds in (a) cereal crops underseeded with certain forage legumes, (b) the establishment of pure stands of forage legumes, (c) forage legume seed production fields, (d) flax, (e) tolerant crop plants such as corn or rice grown in the vicinity of crops highly susceptible to the phenoxyacetic and alpha- phenoxypropionic acids such as cotton and grapes, and (f) certain other weed-crop situations (14).

Recent studies have also shown that plants can produce the opposite effect by changing a herbicidally active chemical into a nonphytotoxic one. 2-Chloro-4, 6-bis (ethylamino)-s-triazine (simazine), a very promising pre-emergence herbicide for weed control in corn, when absorbed by the roots of the corn plant, is converted to a nonphytotoxic form (13). Therefore, corn shows considerable tolerance to simazine. On the other hand, many important weeds do not effectively metabolize simazine to an inactive chemical. These weeds are highly susceptible to injury and are easily controlled by simazine. Thus the metabolic fate of simazine in plants is opposite to that of 4-(2,4-DB).

Another fundamental investigation showed that 2,2-dichloropropionic acid (dalapon) and several other chloro-aliphatic acids inhibit the enzymatic synthesis of panthothenic acid, a B-Vitamin essential to plant growth. Pantothenic acid is made by an enzyme which couples beta-alanine to pantoic acid. This enzyme has been isolated. The herbicides were shown to be competing with pantoic acid. The response of plants to dalapon may be due to the temporary inhibition of pantothenic acid synthesis. This was demonstrated by supplying pantothenic acid to barley leaves. The exogenous source of pantothenic acid partly protected dalapon-treated plants against the herbicidal action of dalapon(6).

These are but a few examples of how fundamental research contributes to a better understanding of the sites and mechanisms of actions of herbicides. These investigations have provided the knowledge that plants also play a significant role in the selective action of herbicides. A basic knowledge of the sites and mechanisms of action of herbicides will enable scientists to synthesize new and even more effective selective herbicides.

Fate of Herbicides and Herbicide Residues in Plants and Soils

Our agricultural progress, especially in weed control, has been characterized by the discovery, development, and utilization of human, mechanical, biological, and chemical energy. The development of these various types of energy has represented a gradual but steady increase in the mechanization of weed control practices in crop production. If maximum benefits are to be realized from this vast, versatile, efficient, and economical source of chemical energy from herbicides, we must develop a fundamental knowledge of their effects on plant growth, and their fate in plants, soils, animals, and humans. The fate of herbicides in plants then becomes a critically important aspect of chemical weed control research in crop production. It represents an additional dimension in weed control research which must be more fully understood.

The fate of herbicides in plants is determined by morphological characteristics, physiological processes, and the biochemical properties of the photoplasm of plants as influenced by environmental and edaphic factors affecting plant growth (15).

Most herbicides can be recovered from plant tissue as the original molecules even though major percentages of the compounds may have undergone changes in chemical structure. Consequently, we are not certain of the actual chemical structures through which many of the herbicides exert their growth-controlling actions. Conceivably some herbicides are applied in one form, translocated in a degraded or metabolized form, and cause inhibitions of growth at the site of action as yet another chemical structure. Other chemicals seem to be absorbed, translocated, and accumulated at the site of action as the original molecules.

Whether herbicides arrive at the site of action in plant cells as the originally applied molecules, or as degraded toxic metabolites, the accumulative evidence available today suggests that soil, morphological, translocation, physiological, and biochemical obstacles and their interaction with environmental and edaphic influences determine the selective action of herbicides by influencing the concentration of the herbicide that reaches the site of action at any one time. It is also conceivable that the site of action in different species possesses differential susceptibility to the toxicant (figure 5).

The fate of chemicals in plants is a relatively recent subject for scientific investigation. In view of the complexity of the subject, it is not surprising that after 10 years of study we still know comparatively little about metabolism of herbicides in plants. Future research designed to uncover the principles which determine how and in what form chemicals reach the growth sites involved in herbicidal action will aid greatly in the solution of weed control problems.

Development of New Principles, Methods, and Techniques

Two recent developments in research on new principles, methods and techniques may have far-reaching effects on chemical weed control. These advances include the development of (a) sub-surface soil-incorporated, pre-planting herbicide application techniques (11,10) and (b) the development of surfactants, carriers, solvents, co-solvents, and other formulation adjuvants which influence initial as well as residual activity of herbicidal chemical (3, 7). These application and formulation techniques provide flexibility for influencing the selectivity associate with the herbicidal properties of the chemical.

The development of techniques and equipment for the sub-surface application of herbicides as soil-incorporated pre-planting treatments or application at planting time will have a profound effect on the use of herbicides. A knowledge of the fundamental chemical and physical properties of new herbicides, especially vapor activity, will aid in determining the need for the sub-surface application of such chemicals. This application technique should provide increased flexibility in controlling deep-rooted perennials, annual weeds which germinate at greater depths in the soil, and weeds in small seeded shallow planted crops. Much additional research will be needed on these recently discovered techniques before their full impact is realized in improved principles and methods of weed control.

DEVELOPMENT OF BASIC WEED CONTROL

Methods and Practices

Outstanding progress is being made in the rapid development of chemical week control methods in crops and specialized noncrop land areas (8). Only a few examples are given below to indicate progress and trends.

Weed Control in Field Crops

The development of efficient, economical herbicides for improved chemical weed control in field crops has almost exceeded the imagination. Cotton can be used as an example to illustrate the potential for improved chemical weed control methods. EPTC has shown promise as a pre-planting soil-incorporated treatment. 3-(3,4-Dichlorophenyl)-1,1-dimethylurea (diuron) is being used as a pre-emergence treatment on a wide scale, and diuron, 2-chloro-4-diethylamino-6-isopropylamino-s-triazine (ipazine), and N-(3,4-dichlorophenyl) methacryl-amide have shown outstanding promise as directed post-emergence herbicides in cotton.

In sugarcane, the substituted *N*-phenylureas, the substituted *s*-triazines, the substituted phenylacetic acids, the substituted benzoic acids, the phenoxyalkylcargoxylic acids, TCA, pentachlorophenol (PCP), dalapon, and other herbicides, can be used to control specific weeds.

The *s*-triazines have shown outstanding potential for weed control in corn. The *s*-triazines and phenoxy compounds will also control a wide spectrum of weeds in sorghum. The new herbicide 4-(2,4-DB) will make it possible to control broadleaved weeds in small grains underseeded with legumes on more than 36 million acres of crop land that could not be treated in the past because of the susceptibility of the legumes to 2,4-D and related herbicides.

A new herbicide, 3,4-dichloropropionanilide has given outstanding control of weedy grasses and broadleaved weeds in emerged rice. Amiben shows promise for weed control in soybeans. Several herbicide mixtures, including 4,6-dinitro-o-sec-butylphenol (DnBP)plus isopropyl N-(3-chlorophenyl) carbanate (CIPC), DNBP plus sodium 2,4-dichlorophenoxyethyl sulfate (sesone), DNBP plus amiben, and other mixtures appear outstanding as early emergence treatments for weed control in peanuts. Trichloroacetic acid (TCA), dalapon, barban, 3,6-endoxohexahydrophthalic acid (endothal), and other herbicides add flexibility to the chemical weed control program in sugarbeets.

Weed Control in Horticultural Crops

Equally striking advances in the development of improved chemical weed control methods have occurred in horticultural crops. The development of the substituted N-phenylurea herbicides for weed control in asparagus, mixtures of CIPC and CDEC for weed control in the cole crops, 4-(2,4-DB) for the control of broadleaved weeds in peas; the s-triazines for weed control in sweet corn and grapes; and the substituted phenylacetic and benzoic acids, and other herbicides for weed control in bulb crops are but a few examples of the progress being made. Pre-planting soil-incorporated treatments utilizing volatile herbicides such as the carbamates hold unusual promise for new chemical weed control methods in vegetable crops.

Forage Crops, Pastures, and Rangelands

Outstanding progress is also being made in the development of improved chemical methods of weed control in pastures and rangelands. The development of EPTC as a pre-planting soil-incorporated treatment for the establishment of alfalfa, red clover, white clover, birdsfoot trefoil, and other legumes; 4-(2,4-DB) and dalapon and combinations of these two herbicides for the control of weeds in the establishment of grasses and legumes for grazine, dalapon and other herbicides for pasture renovation; 2,4-D, 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T), 2-(2,4,5-trichlorophenoxy) propionic acid (silvex), the substituted benzoic acids, and substituted phenylacetic acids for weed and brush control; the use of pelleted and granular formulations of the phenoxy compounds, benzoic acids, and phenylacetic acids for individual plant treatments; and 2,3,5,6-tetrachloroterephthalic acid and 0-(2,4-dichlorophenyl)-0methyl isopropylphosphoramidothioate for weed control in turf are but a few examples of recent developments which provide wide flexibility in controlling a broad spectrum of annual and perennial herbaceous weeds and woody species in forage crops, pastures, and rangelands.

Aquatic Weeds and Noncrop Land Areas

Excellent progress has also been made in developing techniques and equipment for evaluating new chemicals for their aquatic herbicidal properties. These techniques are already beginning to pay off in the discovery and development of improved herbicides in aquatic habitats. Herbicides such as 2,4-D, 2methyl-4-chlorophenoxyacetic acid (MCPA), 2,4,5-T, silvex, 4-(2,4-DB), and the substituted phenylacetic and benzoic acids can be used effectively to control a wide spectrum of floating aquatic weeds. The aromatic oils, aromatic solvents, and polychlorobenzenes have been supplemented by acrylaldehyde (acrolein), the substituted phenylacetic, benzoic acids, and 1,1-ethylene-2,2-dipyridylium dibromide (diquat), for the control of submersed weeds.

Soil sterilants which can now be used for the control of all vegetation on noncrop land and industrial sites have been developed. Soil sterilants with almost any desired residual activity in the soil can be selected. Such herbicides as the substituted N-phenylureas, s-triazines, phenylacetic acids, benzoic acids, and combinations of these compounds, when mixed with such chemicals as dalapon, amitrole, the phenoxy compounds, sodium chlorate, borax, and others will give immediate control of annuals with varying periods of residual weed control for all types of vegetation.

Weed Control, A Total Farm Problem

In attempting to determine how research may result in better weed control methods for more efficient crop and livestock production, it must be recognized that we are now entering a new era which involves the utilization of various forms of energy, not only to control weeds but also to control insects and diseases and for crop protection and crop production in a wide variety of ways. Increasing emphasis on basic research and education programs will be required if we are to utilize the chemical energy of herbicides most effectively in the future.

There is increasing evidence that mechanical equipment will be used more and more in the future to transport chemical energy. The herbicides will be the sources of energy and they rather than the machine with which they are applied will perform the work. This does not imply that the need for mechanical equipment will be reduced. Quite the contrary. It means greater emphasis on specificity and accuracy in placing the chemical energy in the exact amount, in the exact place, and at the exact time for it to perform its maximum work.

We must keep in mind that weeds are a total farm liability and all crops grown on the farm are subject to their competition. In our future thinking and planning we must give greater consideration to weed control problems on the farm as a farm unit rather than limit research techniques to the control of weeds in a single crop. The cost of controlling weeds in a single crop undoubtedly appears high because only that crop is being considered rather than the total weed problem in all crops grown on the farm.

To obtain a better balanced and more efficient weed control program in crop production, farmers must be encouraged not only to use chemical weed control methods for controlling weeds in the current crop, but to place greater emphasis on supplementing this program by the rotational use of herbicides on all tolerant crops throughout the rotation.

We also need to expand our studies on the possible rotation of different herbicides on the same crop grown continuously. Herbicides possess differential selectivity and specificity and rotating them will aid in preventing undesirable ecological shifts in weed populations and reduce the chance of an accumulation of herbicide residue in the soil.

We also need to learn more about the efficiency of rotating different herbicides on different crops throughout the rotation. This practice will permit continuity in the use of chemical energy to control weeds, and reduce weed seed populations in the soil.

Rotating different herbicides on the same crop grown continuously and full utilization of different herbicides on tolerant crops throughout a crop rotation establish the sound principle of preventing undesirable shifts in the weed population, avoiding an accumulation of herbicide residues in the soil, and providing for the full use of chemical energy in combination with cultural practices to reduce weed seed populations in the soil (tables 3 and 4).

Extent, Cost, and Value of Herbicides Used on American Farms

Farmers have demonstrated outstanding interest in the use of chemicals to control weeds. Herbicides are being applied on more than one of every 10 acres of cultivated land. It is estimated that over 150 million pounds of herbicides are being used annually on over 75 million acres of crop lands and industrial sites at a cost of approximately 300 million dollars.

About 70 percent of the acreage being sprayed for weed control is being treated by farmers with their own equipment. Custom operators are furnishing and applying the herbicides on the remaining 30 percent of the total acreage (2).

A recent survey by the U.S. Department of Agriculture in cooperation with 48 of the states showed that about 50 million acres of agricultural land was treated for weed control in 1959 (table 1). The acreage treated with herbicides in 1959 was more than double that of 1949 (table 2).

More than 16 million acres of corn were treated in 1959 at a cost of about 36 million dollars. Chemical weed control in corn eliminates two cultivations. Since each cultivation costs about $1.50 per acre, the benefits from reduced cultivations alone on 16 million acres are estimated at 12 million dollars annually. Additional benefits are derived from reduced weed seed populations, improved harvesting efficiency, greater mechanized production, and higher yields and quality due to reduced weed competition for light, moisture, and nutrients (4).

The data in table 1 also indicate that in 1959 farmers sprayed more than 19 million acres of small grains, over 2 million acres of sorghum, more than 1 million acres of cotton, 1/2 million acres of soybeans, more than 1/2 million acres of rice over 1/4 million acres of vegetable crops, more than 2 million acres of pasture, 4 million acres of rangelands, and 2 1/2 million acres of noncrop land (table 1).

A recent report published by the Minnesota State Department of Agriculture indicates some important trends in the expanding use of herbicides in that State for the past 8-year period (1). In 1950, there were 18,964 sprayers as compared with 31,151 in 1956, an increase of 61 percent. In 1950, Minnesota farmers sprayed 1,910,917 acres of grain crops, 13 percent of the total planted; while in 1958 (8 years later) they sprayed 5,053,857 acres of grain, 44 percent of the total grain crops planted in the State. This report also indicated that in 1956 over 44 thousand miles of township, county, and state highway rights-of-way, 4 thousand miles of railroad rights-of-way, 4 thousand miles of power line utility rights-of-way, and 3,500 miles of ditchbanks were sprayed for weed control in a single state.

These are but a few ways in which farmers, nationally and in a single state, are using improved chemical weed control methods to reduce weed losses and improve crop yields and quality.

A Look to the Future

No one would attempt to predict what new discoveries might develop in weed control from intensive fundamental research involving chemistry, plant physiology, genetics, crops and soil science, and agricultural engineering. We can be certain, however, that unless fundamental and applied studies are brought into better balance and expanded, applied studies in the development of weed control practices in crop production will suffer. The use of herbicides in some instances is beginning to exceed the fundamental and applied research information available to insure their safe use. If a better balance between research in weed control and the use of chemicals is not obtained and maintained in the immediate future the risk of damage to crops will increase.

If a seed is to germinate, a number of environmental conditions must be met prior to germination. If these conditions do not occur, the seed does not germinate. When basic research is inadequate, the shut-off period in scientific development is not as immediate and definite as with the germination of a seed but it is almost as certain in the long-run. Yet all of us are keenly aware of the difficulties involved in developing and obtaining support for such programs.

I am convinced that our weed control progress will be characterized by the discovery, development, and utilization of more efficient forms of energy in the future. The adaptability of chemical energy for controlling weeds offers almost unlimited possibilities for improving the efficiency of weed control. Thus it seems that our future rate of progress will be largely determined by (a) the discovery of more selective, more specific, better translocated, more efficient, better formulated, safer, and more economical herbicides; (b) a basic fundamental understanding of the effects of chemicals on plant growth and soils; (c) our ingenuity in supplementing and combining chemical and cultural practices; (d) a fundamental understanding of the limitations of our current weed control practices; and (e) the development of new and more effective weed control techniques and the discovery of more effective and more efficient sources of energy for selective weed control.

The development of improved chemical, cultural, biological, mechanical, and combination weed control practices represents one of the most effective approaches to increased efficiency, and lower cost, mechanized, crop production.

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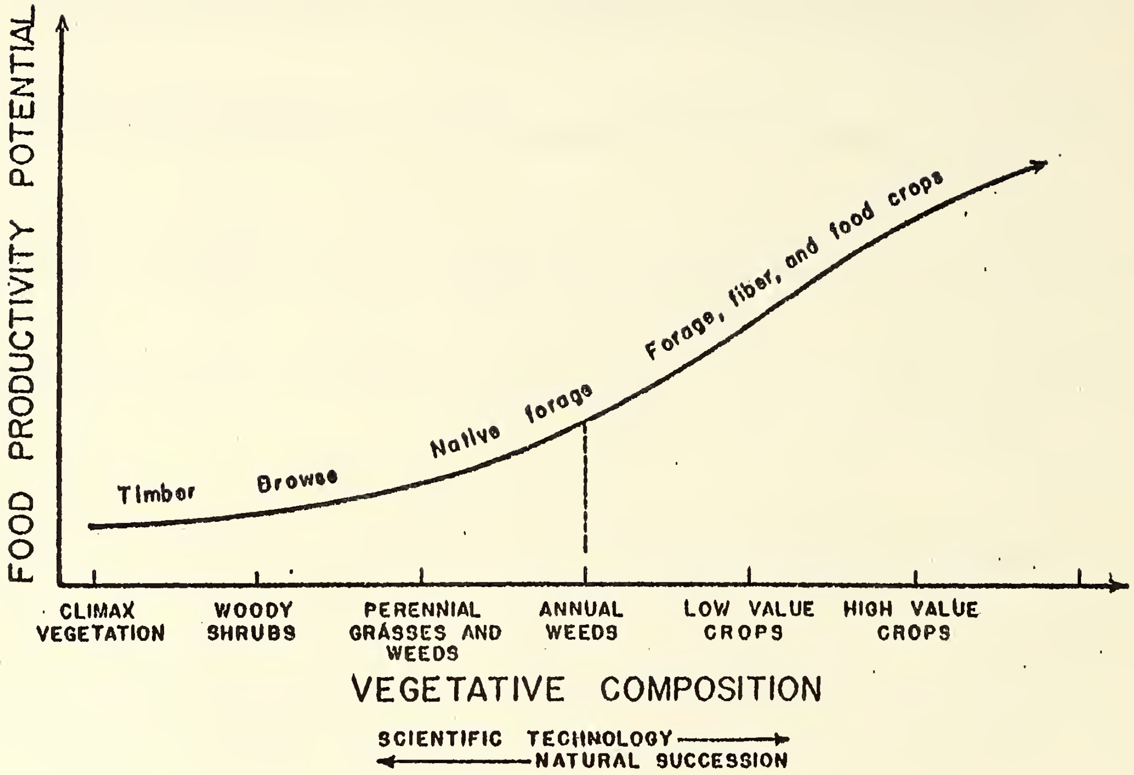
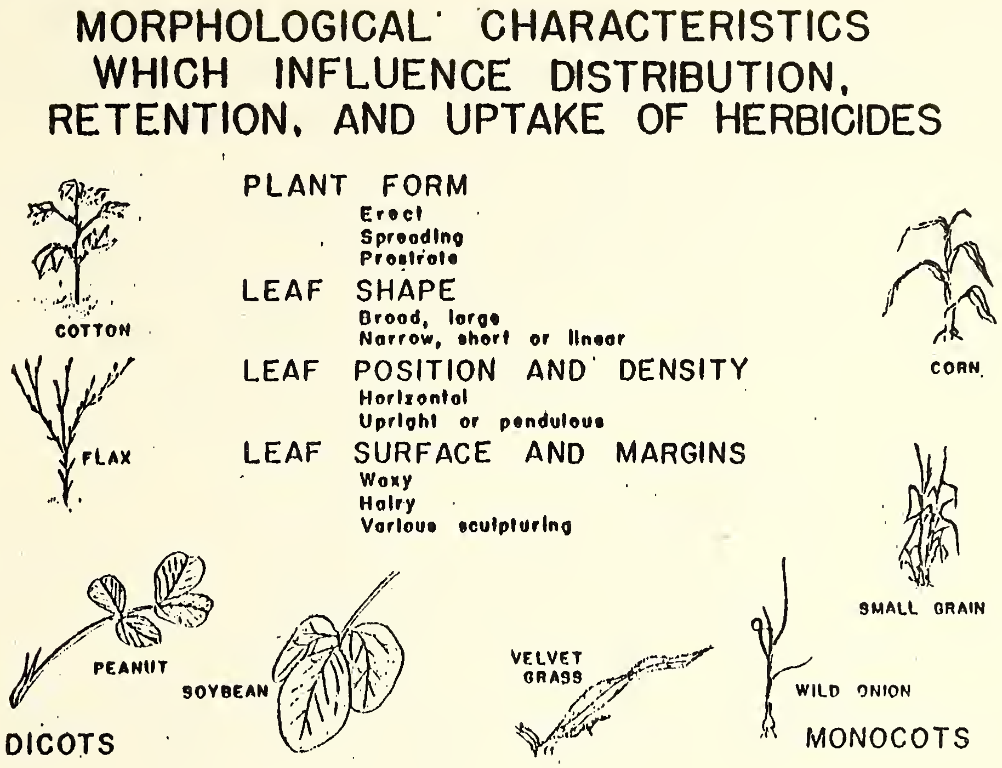


From Shaw et al (15)

Figure 1



MORPHOLOGICAL CHARACTERISTICS WHICH INFLUENCE DISTRIBUTION, RETENTION, AND UPTAKE OF HERBICIDES

PLANT FORM
- Erect
- Spreading
- Prostrate

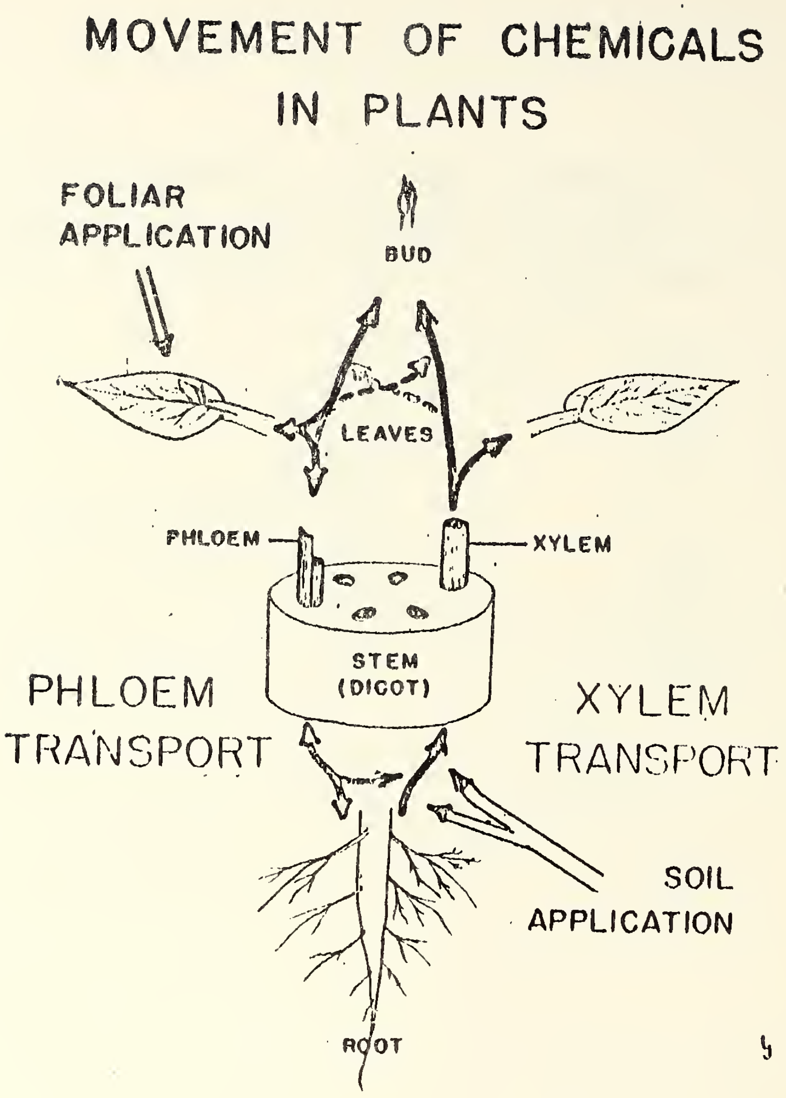
LEAF SHAPE
- Broad, large
- Narrow, short or linear

LEAF POSITION AND DENSITY
- Horizontal
- Upright or pendulous

LEAF SURFACE AND MARGINS
- Waxy
- Hairy
- Various sculpturing

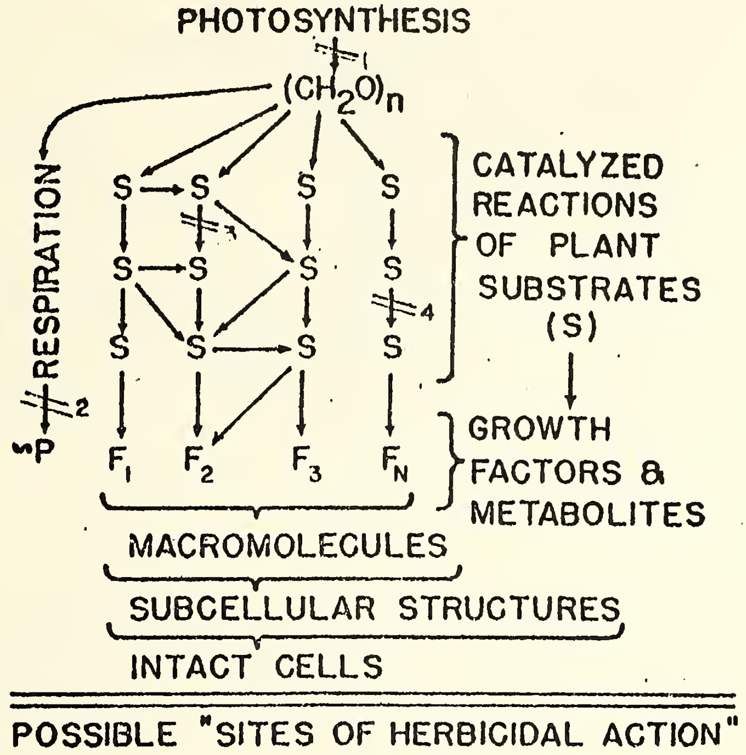
From Shaw et al (15)

Figure 2



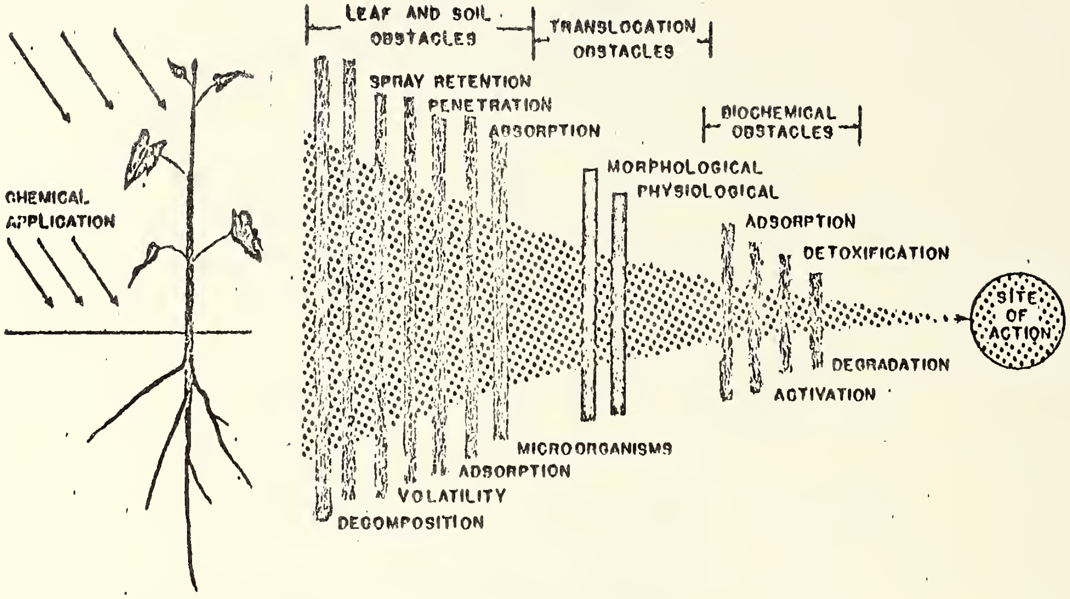
From Shaw et al (15)

Figure 3



From Shaw et al (15)

Figure 4



OBSTACLES WHICH DETERMINE THE CONCENTRATION OF TOXIC MATERIAL AT THE SITE OF ACTION.

From Shaw et al (15)

Figure 5

TABLE 1.--Estimated total acres treated for weed control on farms in United States, 1959[1]

Crop or area	Post-emergence	Pre-emergence	Total
Peanuts	3,000	29,130	32,130
Sorghum	2,075,000	8,000	2,083,000
Sugar beets	44,200	78,600	122,800
Small grain	19,475,200	500	19,475,700
Corn	14,224,370	2,198,300	16,422,670
Cotton	278,600	890,600	1,169,200
Soybeans	10,000	518,435	528,435
Rice	637,000	0	637,000
Vegetable crops	204,080	71,865	275,945
Fruits and nuts	5,425	35	5,460
Strawberries	3,300	2,000	5,300
Lawns	63,800	1,250	65,050
Ornamentals	2,240	210	2,450
Pastures	2,212,450	30,100	2,242,550
Rangelands	4,296,000	0	4,296,000
Hay	186,400	0	186,400
Forage seed	261,300	100	261,400
Subtotal	43,982,365	3,829,125	47,811,490
Noncrop land	2,889,500	200	2,889,700
Total	46,871,865	3,829,325	50,701,190

[1] From unpublished survey data accumulated by the Federal Extension Service; Farm Economics Research Division, and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture. Estimates for Alaska, California, Delaware, Hawaii, New Jersey, New York, Ohio, Oklahoma, and Washington not included.

TABLE 2.--Estimated acreages treated for weed control in United States[1]

Year	Corn	Small grains	Grazing lands	All other	Total
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
1949	4,559	18,751	---	---	23,310
1952	8,150	16,792	2,192	2,629	29,763
1959[2]	16,423	19,496	6,500	[3] 5,375	47,794

[1] Estimates for 1949 and 1952 from U. S. Department of Agriculture, Statistical Bulletin 156, April 1955; 1959 estimates from unpublished survey data accumulated by the Federal Extension Service; Farm Economics Research Division and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

[2] Estimates for Alaska, California, Delaware, Hawaii, New Jersey, New York, Ohio, and Washington not included.

[3] Estimated 2.9 million acres noncrop land treated not included.

Table 3. Rotation of Different Herbicides on the Same Crop 1/

Year	Crop sequence	Chemical Weed Control Treatments	
		Pre-emergence	Post-emergence
First	corn	simazine	2,4-D
Second	corn	CDAA + 2,3,6-TBA	2,4,5-T
Third	corn	atrazine	2-(2,4-DP)
Fourth	soybeans	PCP	--

1/ Hypothetical rotation used to illustrate the principle of keeping maximum pressure on the weed population by the use of a series of herbicides which differ in their effectiveness in controlling various weed spectrums. This procedure reduces the chance of a species that is tolerant to a specific herbicide from becoming dominant. It also reduces the chance of an accumulation of herbicide residues in the soil.

Table 4. The Use of Various Herbicides on All Crops in a Rotation 1/

Year	Crop sequence	Chemical Weed Control Treatments		
		Pre-planting	Pre-emergence	Post-emergence
First	corn	EPTC	simazine	2,4-D
Second	peanuts	--	sesone	DNBP
Third	cotton	--	diuron	simetone
Fourth	soybeans	EPTC	PCP	--

1/ See footnote, Table 3.

SORGO RESEARCH [1]

by

Otto H. Coleman

Sweet sorghum (sorgo) research of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, is designed (I) to develop new, improved varieties of sweet sorghum that have high-yielding ability, high-sugar content, resistance to diseases and lodging, and adaptation for sirup and sugar production under a wide range of environmental conditions in the Untied States (II) to evaluate physiological factors that influence quality of the sirup and of the juice between harvesting and milling (III) to develop improved fertility and handling practices for the optimum production and maximum return from current commercial and new varieties of sweet sorghum; and (IV) to develop improved and more economical cultural practices for optimum production of current commercial and new sweet sorghum varieites.

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[1] Investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and cooperating agencies.

The major part of the research is carried on at Meridian, Mississippi, but research is also centered at Cairo, Georgia, Brawley, California, and Beltsville, Maryland. Cooperative tests are conducted at 26 additional locations in 9 southeastern states.

Among the problems connected with sorgo production are land preparation, number of plants per acre, kinds of fertilizers, methods of weed control, insect damage, diseases, time of harvest, and so forth. The research program has provided solutions for some of these problems and research on others is in progress.

The breeding program (Table 1) involves 3 basic approaches to obtaining improved sorgo varieties for release to farmers. One is importation of varieites from other countries. Through the years more than 4500 varieties including related grasses have been brought into the United States, and about 3300 of these have been evaluated for breeding potential at Meridian. Approximately 1600 were in the collection made by C. O. Grassl in Africa. This expedition was partially financed by the American Sugar Cane League. Superior germ plasm involving resistance to diseases was imported with this group. In fact, the variety "Sart" was released in the exact form in which it was received. All the disease-resistant varieties being used in the breeding program at present are part of the collection made by Mr. Grassl.

The second phase is the crossing program. Most of the importations resistant to diseases and lodging have other desirable characteristics, but none except Sart is suitable as a commercial variety. Consequently, more than 1000 bi-parental crosses have been made combining the good characters of the domestic and imported varieties. More than 300 crosses involve more than 2 parents. Over 200,000 F_2 plants have been evaluated. There were 183 recent importations, 10 domestic varieties, and 7 varieites of our own origin used in these crosses. As a result, we have released the variety Wiley for sirup production in the southeastern states and the variety Brawley for sugar production in California.

The third breeding approach is the development of male-sterile sorgo hybrids for sugar and sirup production. Actually, seed appear to be a handicap if hybrid sorgo is to be used for these purposes, because the carbohydrates which would normally to into the seed might be laid down in the stalk as sugar if no seed were produced. Also, a head heavy with seed is likely to cause lodging, particularly with high winds. The cytoplasmic male sterility of Combine Kafir 60 (grain type) is being transferred to sweet sorghum. More than 100 sorgo hybrids have been evaluated and some of these have involved male-sterile Combine Kafir 60. In some cases, the hybrids produced consideralby higher yield of stalks than either parent, but this is usually associated with a taller stalk which has a greater tendency to lodge. Crosses between high-yielding sorgo and Combine Kafir 60 (Table 2) usually yield about the same as the sorgo and are no taller. Brix readings of a few of the hybrids are equal to those of the best parent but none are superior. There is some indication, however, that an increase in purity may be obtained by the use of the proper parents.

Resistance (Table 3) to leaf anthracnose (Colletotrichum graminicola (Ces.) G. W. Wils.), red rot (also C. graminicola), rust (Puccinia purpurea Cke.), and zonate leaf spot (Gloeocercospora sorghi Bain & Edg.) has been shown to be controlled by single-factor pairs in the dominant condition. Lodging resistance in one cross was also shown to be dominant. These desirable characteristics are being incorporated in new varieites as rapidly as possible. At present, studies are being conducted on the inheritance of resistance in sorghum to the sugarcane mosaic virus and to injury from cotton insecticides such as methyl parathion.

Rust is a very important disease in southern Louisiana. Studies (Table 4) conducted at Houma and Meridian indicate that the loss of sugar in the stalks of sorgo is directly proportional to the severity of rust infection; under conditions of severe rust infection early in the season, there was an average loss of 20 to 25 percent of the sugar in the juice.

As a result of the breeding program for disease resistance, some lines are available that are much better adapted to the "Sugar Belt" in Louisiana than domestic varieties. Rust infection last year was late in the season and did not adversely affect the two susceptible varieties, Brawley and Rex, in the variety test at Houma (Table 5). Normally, the juice quality of these two varieties would be rather low in southern Louisiana. The quality of the rust-resistant variety, Mer. 55-1, however, would be expected to be about the same as in 1960 even under conditions of a severe rust infection early in the season. This variety had a Brix of 18.5 in 1960 and a sucrose content of 14.0, and yielded 183 pounds of sugar per ton of stalks when a conservative estimate of 75% extraction was used. The estimated cost of producing this crop under Louisiana conditions is about $70 per acre. The tonnage of stalks and consequently sugar per acre should be increased substantially be shifting from the 6-foot row to a 3 to 3.5-foot row, because sorgo does not have a long enough growing period to take advantage of the wide row.

The problem of inversion of sugars in cut stalks of sorgo has been studied also. Varieties like Brawley and Rex hold up very well for two or three days in storage if the stalks are kept wet by sprinkling. On the other hand, the sugar in varieties like Sart inverts very rapidly during storage.

Ten years of data collected in Mississippi indicate that there is very little difference in yield on 3.5-foot rows between plants spaced 1 inch apart and 3 plants in hills two feet apart. In other words, 18,800 plants per acre yield about the same as 149,000. Sorgo plants in hills have larger stalks and have less tendency to lodge.

Many fertilizer tests indicate that 40 pounds of N per acre is adequate for sorgo if P_2O_5 and K_2O are optimum.

Table 1. Sorgo Breeding as of June, 1961

	No.
Recent Importations Evaluated	3300+
Crosses	
Parents	
Recent Importations	183
Domestic Varieties	19
Hybrids	7
Segregating Populations	
Single Crosses	1000+
Multiple Crosses	300+
F_2 Plants	200,000
Hybrids Evaluated	100+

Table 2. Hybrid Sorgo

Parents and Cross	Brix degrees	Sucrose %	Apparent Purity %	Stalk Length inches	Weight Per Plant lbs.	Date Harvested
CK 60 1/	14.6	8.3	57.4	17	1.0	Aug. 19
CK 60 x Tracy	16.5	11.9	72.0	74	9.5	Sept. 5
Tracy	16.6	11.4	68.1	88	9.2	Sept. 11

1/. 1959-60 (Two tests)

Table 3. Genetic studies of agronomic characters of sorgo

Leaf Anthracnose Resistance	(Ll)	*C. graminicola* (Ces.) G. W. Wils.
Stalk Red Rot Resistance	(Lsls)	
Rust Resistance	(Pupu)	*P. purpurea* Cke.
Zonate Leaf Spot Resistance	(Glgl)	*G. sorghi* Bain & Edg.
Lodging Resistance	(Ee)	
Sugarcane Mosaic Virus Resistance		Currently being studied
Methyl parathion Resistance		

Table 4. Rust ratings and juice quality of 74 sweet sorghum varieties grown at Meridian, Mississippi, and Houma, Louisiana. 1956

Rust rating at Houma	Number of Varieties	Average Brix Meridian	Average Brix Houma	Brix at Houma in percent of that at Meridian	Loss of Brix due to rust at Houma
		degrees	degrees	%	%
0	15	19.3	15.6	80.8	0
1	3	18.2	13.4	73.6	8.9
2	9	18.2	13.3	73.0	9.7
3	19	18.6	13.2	71.0	12.1
4	28	18.6	11.6	62.4	22.8

Table 5. Sorgo Variety Test
Houma, Louisiana, 1960

Variety	Brix	Sucrose	Apparent Purity	Sugar/ton
	degrees	%		pounds
Mer. 55-1	18.5	14.0	75.9	183
Brawley	18.8	14.8	78.6	198
Rex	18.3	14.1	77.4	187
Average	18.9	14.3	77.3	
L.S.D. 5%	N.S.	N.S.	0.9	
1%	N.S.	N.S.	1.3	

THE LOUISIANA SUGAR BEET STORY

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The idea of growing sugar beets in Louisiana was first suggested by Dr. W. C. Stubbs about 1886. Dr. Stubbs envisioned the possibility of operating the sugar factories for an extra two to three months of the year if sugar beets could be grown successfully. Test plots of sugar beets have been grown at the Experiment Station since 1886, the most concerted effort was made in 1924 by A. F. Kidder and Dr. C. E. Coates (3).

In 1925, as a result of the sugarcane failure, interest in beet growing became more general throughout the state. Sugar beet machinery was installed in the sugar factory at the Experiment Station in Baton Rouge. In the fall and winter of 1925-26, plantings of beets were made at a number of plantations in the sugar belt. Altogether, on twenty-nine different plantations in fifteen parishes. In 1926 the yields and sucrose from the larger plantings which were harvested in May and June (1) and shown in Tables 1 and 2 were quite disappointing when compared to the yields obtained from smaller plots. Yields from most of the plantation trials were less than five tons of beets.

The following factors contributed to the poor yields obtained in 1926:

1. Improper soil preparation and deficient drainage, as compared to the small plots.
2. An excessively heavy rainfall during the early months of 1926. (January, February and March rainfall that year was the heaviest in the history of the Weather Bureau).

3. The occurrence of two very destructive rot diseases. The losses from these two diseases ranged from 40 to 100 per cent, with an average of about 70 per cent.

In 1927, about two hundred acres of beets were grown. The early plantings were practically all killed by a freeze in early January, and it was necessary to replant. Dr. Coates and Kidder found that September and October were the best months to plant. In order to prevent the rot which occurred in 1926, the beets were rushed to the mill during the first few days in May before the temperature had become high. As usual, beets that were left in the field during the latter part of May and the first of June rotted very severely. Final results of the 1927 crop are not available. Mr. Barrow, scientist in charge of sugar beet testing for La. Agr. Expt. Sta. died in 1928 and no Annual Report was written in 1928.

After the 1927 work, the beet work was continued for a few years by the Experiment Station and growers throughout the state. Growers lost interest in sugar beets at that time for the following reasons: 1) new sugarcane varieties introduced in the state were making good yields, 2) diseases caused such heavy losses that it seem impossible to grow sugar beets on a commercial scale until satisfactory control measures could be worked out.

Sugar Beet Diseases

Drs. C. W. Edgerton and E. C. Tims (2) working on sugar beet diseases concluded after several years observation and research that disease problems connected with growing of sugar beets in a warm subtropical climate should be carefully considered in future attempts to grow beets in Louisiana. Diseases of economic importance in Louisiana are two which rot the beet itself - Rhizoctonia and Sclerotium rot, two leaf diseases and the nematode gall disease.

Table 1. A sample of the sugar beet crop produced in Louisiana, 1926.

Location	Acreage	Per cent Stand	Yield Per Acre(T)	Cost to Deliver	Per cent Rotted	Remarks
Glenwood	3.5	90	1.4	$17.85	70	Replanted
R. T. Gibbens	4.8	70	3.2	3.00	15	"
J. W. Supple	4.8	80	6.0	6.66	50	Interplanted
S. J. Gianelloni	2.0	70	5.0	6.92	40	Replanted
A. Wilbert & Sons	1.5	60	6.9	5.40	40	Interplanted
La. State Penn.	4.5	80	11.3	2.25	40	"
Smithfield	3.6	50	2.4	4.60	60	Replanted (2)
Standard Sugars	6.0	60	10.6	10.55	70	Interplanted
Waterford	4.7	75	4.5	3.98	75	"
Angola	5.0	75	4.2	4.17	30	--
H. K. Bubenza	1.3	60	Not taken	--	60	Too late March planted
C. M. Roy, Opelousas	2.5	50	--	--	20	Hail injury
Test I - La. Expt.Sta.	5.0	90	7.4	--	20	Interplanted
Test II - La. Expt. Sta.	3.0	80	8.0	--	15	"

Table 2. A sample of analysis of sugar beets for crop year 1925-26.

Date 1926	Location	Brix	Sucrose	Purity	Date 1926	Location	Brix	Sucrose	Purity
May 10	Dutchtown area	14.10	11.80	83.70	May 29	Cinclare area	14.90	11.61	77.90
May 26	Dutchtown area	17.95	15.15	84.40	May 27	Thibodaux area	14.80	11.94	80.70
May 10	Geismar area	12.97	12.37	79.90	June 9	Bunkie area	-	12.20	82.70
May 26	Geismar area	16.55	13.56	81.90	July 29	Bunkie area	17.18	14.07	82.00
May 19	Bayou Goula area	14.55	11.51	79.10	June 9	Opelousas area	-	11.60	78.40
May 29	Bayou Goula area	16.45	13.41	81.50	June 18	Hohen Solms area	18.40	15.36	83.50
May 21	Godchaux Reserve area	14.07	11.74	79.90	May 24	St. Gabriel area	12.35	9.56	77.40
June 11	Godchaux Reserve area		13.04	83.30	May 26	La. Agric. Expt. Sta. (black land)	16.70	13.94	83.50
May 22	Waterford Killona area	15.75	12.86	81.70	May 26	Angola area	15.30	12.54	81.96
May 26	Napoleonville area	14.55	11.15	76.60					

Rhizoctonia Rot. This disease appears in the cool winter and spring while Scleortium rot occurs only in warm weather. There is some overlapping of the two diseases in April and May, but in general the Rhizoctonia disease decreases with the approach of warm weather, while Sclerotium injury increases. The Rhizoctonia rot causes leaf dying and rotting of the beets at the crown region and sometimes below the soil line. Crack and malformed beets are produced. The principal injury to the beet by this disease is the rotting of the leaves and crown. The presence of this disease on beets does not cause any trouble at the mill.

Sclerotium Rot. Beets affected by this disease, the most serious of all beet diseases known in Louisiana, show a yellowing and wilting of the outer leaves, followed by a sudden wilting and collapsing of all the leaves. The disease begins near the soil line and spreads rapidly over the exposed surface of the beet. Below the soil line, the rot develops slowly and only rarely does it reach the base of the beet. Under favorable conditions, the reproductive bodies of the fungus which resemble mustard seed form on the surface of the beet.

In 1926 the severity of the rot varied from only a trace in a very few fields to or as high as 75 per cent in one field. The rot became much more severe as the temperature rose in the spring, and in most of the fields that were not dug until after the temperature became high the beets rotted so severely that they were worthless for milling. Spread of the Scleortium rot in shipping cars was also a very serious problem in 1926. One car, for example, containing eighteen tons of beets was practically destroyed by the rot fungus during the four days that elapsed between loading and arrival at the factory.

The authors stated with reference to leaf diseases that leaf spot occurs in Louisiana but is not serious and does not produce a rotting of the beet. With reference to the nematode root gall, it was stated that beets are susceptible and would become a grave problem if beets were grown commercially on sandy soils.

The following are some statements by Mr. D. N. Barrow scientist in charge of sugar beet testing for the Louisiana Agricultural Experiment Station for the beet crop year 1925-26.

The history of Test II (Table I) at the Louisiana Agricultural Experiment Station at Baton Rouge, Louisiana is rather remarkable according to Mr. Barrow. He stated that the land upon which the beets were planted in November was the blackest and stiffest upon the place. It had been in cotton the year before and was prepared with difficulty for fall planting. Heavy rains followed the planting and the land was covered with water for days several times during the winter. About fifty per cent of a stand was obtained from the fall planting and inter-planting was done in February without disturbing the fall plants. The rains continued with the flooding until well into April at which time the plants seemed very sick. They were cultivated and hoed out and took on new life and made a remarkable growth. Yield, 14 tons per acre.

Mr. Barrow commented that if the tonnage secured in 1926 was to be taken as typical of what can be expected every year there would be no further inducement to continue the work with sugar beets. He stated, however, the cause of low tonnage in 1926 was very apparent when one compares these yields with those secured during the former years of experimentation and one should remember that the records show that the weather conditions of 1925-26 had not occurred in the state for eighty years. Plant pathologists attributed the heavy rotting of the beets to the cold water logged soil conditions.

The yield of beets planted upon alluvial soil in 1922 and harvested in 1923 was 19.9 tons per acre. The fall plantings of 1923 gave 18.0 tons in 1924 and the plantings of 1924 gave 23.0 tons in 1925. It was worthy of note, according to Mr. Barrow, that the season of 1923 until well into the spring was unusually wet and that the one in 1924 was the driest year ever experienced, yet the tonnage as well as the sucrose was entirely satisfactory.

The writer experimented on his own in 1955 using new sugar beet varieties. Table 3 gives the results.

Sugar Beet Statistics	1958	1959
Average yield per acre/T USA	17.0	18.8
Average yield per acre/T Western Europe	15.8	13.2
Average yield per acre/T Eastern Europe	13.5	11.5
Average yield per acre/T USSR	9.0	6.6

	1948-57	1958	1959
Season average price/ton in USA	$11.30	$11.70	$11.30

It is the opinion of the writer that sugar beets may possibly be grown, successfully in Louisiana now that better varieties are available. In addition, by use of new fungicides and soil fumigants it may be possible to control the rotting of the beet which has plagued both scientists and growers.

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Table 3. Sugar beet yield results, 1955. Beets planted November 1, 1954, harvested June 7, 1955.

Varieties Tested	Yield/A Beets/T	Weight/A Tops/T	Ave. Wt. Per Beets/lbs.	Yield Losses Due to Rot/T	Percent Beets Rotted	Average	
						Sucrose	Purity
S.L. C-368 Strain U.S. 75	24.8	7.4	2.9	5.1	17.3	11.80	74.17
S.L. No. 7-15 Strain U.S. 15	22.8	6.9	2.5	5.5	19.7	13.30	81.61
S.L. No. 859 Strain U.S. 56/2	17.2	5.6	2.2	8.9	35.2	12.90	79.62
F.C. No. Acc. 1320 - Variety U.S. 225M.S. x 201 2o1B (W.C. 3211F)	29.5	10.7	2.5	4.5	13.5	11.73	77.40
F.C. No. Acc. 1329 - Variety U.S. 400 (W.C. 3500)	28.9	10.1	3.2	5.8	16.7	12.23	75.87

Plot 40 feet long - four replications

Rows - 3 feet apart

Minor damage by Cerospora leaf spot disease

Beets tested on, May 5, 23, and 30, 1955

THE PRODUCTION TRIANGLE

(SCIENTIST - EDUCATOR - PRODUCER)

By E. J. Burleigh, County Agent, Iberville Parish

At the 1960 Annual Meeting and Banquet of the Assumption Parish Farm Bureau, Mr. C. E. Kemmerly, Jr., Assistant Director, LSU Agricultural Extension Service, said,

"I don't think you can find anywhere in the United States a better example of a profitable partnership between practical farming and research than can be found right here in the Louisiana cane belt. Louisiana's cane growers, always searching for better varieties and better methods, always ready to adopt improved practices, found long ago that a well-supported research program can mean the difference between staying in business and going out of business. Research has been the basis of progress in the cane industry since the earliest times.

"The first big agricultural research project here in Louisiana was begun in 1885. It was the work of an organization of sugar planters who were anxious to bring their industry out of the doldrums and difficulties of the reconstruction period. They did not wait for Federal or State aid, but had the vision to see what the industry needed and to begin a research program of their own. They organized the Louisiana Scientific and Agricultural Society which in 1885 raised more than $60,000. by private donations to establish a sugar experiment station in Kenner."

To me the above expresses the feeling of the sugarcane farmer toward research just about as well as it could be expressed. I would like to make my interpretation of his meaning of a "profitable partnership between practical farming and research." I am sure that in this partnership he meant to include "education", and the education I refer to here is the Louisiana State University Agricultural Extension Service, through its county agents and specialists. Because, certainly without some means of disseminating this information to the farmers the vast contribution made by applied research to the efficient and economical production of sugarcane, or of any other farm crop or enterprise, may as well be in the archives of a dead past. I know that most of you here today, who are producers, would undoubtedly dig this information out of the libraries it is placed in, but how many of your neighbors would? Very few, if any, I would dare to say. Therefore, I say that an educational system conceived and designed to bring information from the scientists to the producer must be included in the partnership. Fortunately, as stated above, we have such an educational system in the Agricultural Extension Service.

This meandering then finally brings me to "The Production Triangle, Producer, Educator, Scientist."

Before I go much farther let me say here that I do not mean to convey the idea that I hold that all progress made in agriculture has been made through a direct line starting with the research worker, through the educator, to the producer. In many instances the producer has been all three. A very good example of what I am trying to bring out here is "The American Sugar Cane League". Certainly the League is responsible for much research work and for educational work as well. Many good things have come to us from research and educational work done by commercial firms. By and large, though, we are proud to say, most of this work, or of these findings, had had (and I might add here through the request of the commercial firms) the sanction, approval, coordination (well, I can't seem to find the right adjective, so you supply one and I will go on) of the researchers and educators. What I am trying to say here is that the prestige and confidence that has been built up by the research workers and educators can be and quite often is used to get farmers to adopt practices regardless of the source of origin.

Remember here we are referring to economically sound practices, we hope that we don't too often get caught in a skin game through laxness on our part. I started to use the word "ignorance" but decided against it on the assumption that such a harsh word might offend some of my more highly educated colleagues.

Did I speak of wandering just a little while ago? "Meandering" is the word I think I used, well it looks like I was well on my way up another side road. But it is a little fun to stand here and say some things that are on your mind even though they may not mean too much and to know that your audience is much too polite to leave, or at least to leave in a body.

I think I am supposed to be talking about how the producer, research worker, and extension worker can assist each other. One of these days I am going to take this paper and study it real hard to see if this objective has been accomplished. Now this is the point at which I am going to fool you because you would normally think that when anyone making a talk starts evaluating then his talk must be near the end. Well, it "ain't" because I have a few more words to speak, and I am going to make sure that the objective is at least partially covered now.

In sugarcane, as with many other crops, the research workers and the extension agents get together once each year, at which time latest findings are discussed, recommendations are made by the scientists, and research work being conducted or contemplated is mentioned. Now it would appear here that the so-called "educator" would be the sole beneficiary, but I don't think that such is the case. In meetings of this type many views and opinions are expressed and problems brought out that can be of great help to the research worker in evaluating his present and future programs. How do these meetings help the research worker in evaluating his present and future programs and do these meetings help the grower? Answering the last part of the question first, I would say, it makes the extension worker more proficient in his knowledge and in turn he can be of greater help to the producer. Secondly, through the agents close contact with the growers, he brings to the scientist the producers felt needs.

Next I would like to mention meetings of another type. Each year, in most sugar cane parishes, the county agents sponsor meetingsof producers with research personnel from both the LSU Experiment Station and USDA Houma Station appearing on the program along with other extension personnel. Here you see we are bringing all three groups into close commune. I fully realize that it isn't the specific job of the research worker to be an educator (as this word is being used in this paper), but if I may get personal we have had no trouble in Iberville Parish in getting specialists to attend our meeting, in fact we have had volunteers. I feel quite sure that there is something else that brings these men out on cold, rainy, wintery night. Yes, something even more than their desire to be of help to you the producer. This other something I feel is the research worker's desire to become more intimate with the problems as seen from the producers eyes, thereby making his work, possibly a little easier, and considerably more fruitful.

Along the very same lines only with a different setting are the farm tours. Again producers, scientist, and educator get together to discuss problems, practices, and methods. The tour has an advantage over the meeting in that quite often results of recommended practices can be shown. Now we begin to see how the producer can be of great help to the extension agent and research worker. Making your farm available for such things as tours, field meetings, result demonstrations and out-field tests is one of the base blocks in the production triangle. I don't mean to imply that everything mentioned here-to-fore was without producer contribution, because the simple act of attending a meeting makes us extremely happy.

Just a few more examples of how we can and very often do work together to the mutual benefit of all. The research worker must very often if not always carry his hot-house findings out to the field to prove them under all conditions and to give them the economic test. For it is only when they can pass in the field that they become of value to the farmer. There just isn't land available on the experiment stations (and even if there was this still wouldn't test the practices under a wide enough range of soil and climate variations) to carry out all research work on a field operation scale. So the research worker must depend upon the producers to provide land and sometimes other items of production in completing the project. This type of experimentation has a distinct advantage in that the producer and many of his neighbors can observe the results as they develop and quite often, I am sure, this helps materially in the adoption of a practice. Here the extension worker can be of assistance, especially to the scientist not familiar with the area, in helping to locate a suitable place for the experiment. I have been very careful (or at least I have tried to be very careful) not to step on anyone's toes but now I will have to do a little stomping. It seems that we (county agents) could take a little more interest and possibly use these out-field tests and experiments a little more in our educational program. Now to step on another toe and I hope this will be the last the research workers might be a little more aggressive in acquainting the county agent with the work. It is our opinion that there isn't a wide gulf of differences in this matter but just a little need for more understanding, co-ordination, and co-operation.

There is one field which I have not touched on that should be mentioned. The field I refer to is"Public Affairs" or "Public Policies". I don't know if they are one and the same or different but let's refer to it as Public Policies. Now I ask you where is the dividing line between "Public Policies" and "Partisan Politics?" As you know we (the agents and I guess also the research workers) can't take part in partisan politics, but as educators we have the responsibility of giving information on public policies. Now, as I see it, this is the way we must work together for the benefit of all. When a matter is in the stage of public policies it is the duty of the educator to discuss and inform, and to present both sides of the question in unbiased manner, so that the then informed public will be able to make the wisest choice. But when this public policy matter becomes a matter of partisan politics (as it invariably does) then the ball must be passed to the producer and it then becomes your job to make the score. In the field of governmental programs, we in extension and to some extent the research workers have the responsibility of informing the producers by presenting both the pros and cons to the question. After this it becomes the duty of the producers to get the bill passed or defeated or to get the program changed if it is already in existence and needs changing. I am sure that there are many more public policy matters that could be used as examples but I am going to mention just one more and I have it spelled M O N E Y. Surely the insistence of producers that proper and adequate funds be appropriated for the continuance of a vigorous research-educational program is a must for the survival of us all.

Thank you for inviting me to be on the program.

NEMATODES AND NEMATOLOGY RESEARCH ON SUGARCANE IN LOUISIANA.

Wray Birchfield USDA Nematologist

General Characteristics of Nematodes

Nematodes of man and his domestic animals constitute an important phase of the medical and veterinary professions where they are grouped in the category of parasitology. Certain human parasites, such as hookworm, are averaged sized nematodes with a soil period in the life cycle. But only recently plant nematology, which is the study of plant diseases caused by nematodes, became recognized. Nematodes are a form of animal life often spoken of as roundworms or ellworms, but not to be confused with earthworms or tapeworms with which they have no affinities, nor with sodworms, grubworms, cutworms, etc., which are larval stages of insects. Plant parasitic nematodes are small (average about 1 mm or 1/25 inch), ellshpaed or snakelike in appearance except a few species which are swollen in the adult stage. Considering these organisms as a group they are plentiful in nature, perhaps over 500,000 species, but only about 125 species representing 25-30 genera are plant parasites of crop plants in Louisiana. These feed on the roots of plants, for the most part, but some species attack flowers, foliage, stems and bulbs of certain plants. The life cycle of plant parasites is simple and direct; they lay eggs which hatch into larvae resembling adults. Larvae go through 4 growth periods called molts during which time they are generally able to infect their host plants. In some cases 10-12 generations are produced per year.

They cause injury to plants by the mechanical damage they inflict with a stiletto-like mouthpart, and providing avenues of entry for harmful fungi, bacteria and viruses, but most important by toxins or poisons secreted into plant tissues for food digestion. In several cases extreme swelling and cancerous tissue results, such as, rootknot of tomato.

Nematode parasites of sugarcane

Some of the first work in plant nematology before the turn of the century was done on harmful nematodes of sugarcane. Dr. N. A. Cobb, Father of American Nematology, was active in this phase of the work followed by several Hawaiian workers up to the present time.

1. Burrowing Nematode (*Radopholus similis*)

The burrowing nematode has been reported as a severe parasite of sugarcane and banana in the Hawaiian and Fiji Islands. It was first found in the United States by Dr. R. D. Rands on the Godchaux plantation at Raceland, Louisiana. Since that time it has not been reported from sugarcane but on banana and other ornamental plants in the state. This organism has considerable potential as a plant parasite having destroyed several thousand acres of citrus in Florida and the black pepper industry on the Island of Banka in Indonesia.

2. Rootknot (*Meloidogyne spp.*)

This organism characterized by swelling and root cancer of its host plants has been the subject of continued investigation and volumes of literature since its discovery in 1855. The genus is composed of several species of wide host range. It is an important parasite of sugarcane in Louisiana only in the Cheneyville and Bunkie area of Rapides and Avoyelles Parishes and isolated sandier type soils in the sugarcane area. Symptoms on sugarcane are short, yellow spots in the field with small galls or knots on the roots of infected plants. Yields are drastically reduced.

3. Stunt nematode (*Tylenchorhynchus spp.*)

There are at least 3 known species of this nematode abundantly associated with sugarcane in Louisiana. Research has shown *T. martini* to deplete and stunt the roots of sugarcane in greenhouse studies and at least one field test gave a significant response to soil fumigation where these nematodes were present. It is often found associated with rootrot, poor stands and low yields.

These are root parasites that may enter roots and become internal parasites or feed largely from the outside. Other species have been reported causing damage to tobacco and cotton and increasing Fusarium wilt on cotton.

4. Meadow or Lesion Nematode (Pratylenchus spp.)

At least two species of Pratylenchus are found on sugarcane in Louisiana. These are complete internal parasites of roots where they feed, lay eggs and raise a family in small discolored lesions on the young roots of sugarcane. Greenhouse tests showed T. Zeae to significantly reduce the growth of sugarcane. They are scattered throughout the sugarcane area but only in certain fields do the populations appear to reach harmful proportions. These nematodes have often been found in greater numbers on ratoon stunted cane than on normal cane. Other species of this organism are frequently reported in the literature as disease producing organisms of various crop plants.

5. Reniform nematode (Rotylenchulus reniformis)

The reniform nematode has recently been associated with severe cotton failures in the state in places where sugarcane is included in the rotation. The exact relation of this organism to sugarcane has not been determined but sugarcane appears to be a poor host since only a few males were found on sugarcane in the field. This organism feeds on young roots in the phloem area but the main nematode body stays outside the root, surrounded in a jellatinous matrix in which eggs are produced. Severe necrosis of root tissue surrounding the point of infection takes place.

6. Other plant parasitic nematodes of sugarcane.

There are 18-20 genera, each containing several species, associated with sugarcane in Louisiana. Just how important the bulk of these plant parasites to other crops in the rotation is not known at present. We know, however, that they are obligate plant parasites that derive all their food from the living plant without furnishing anything in return.

(a) The lance nematode (Hoplolaimus tylenchiformis)

This is a relatively large nematode that occurs in small numbers throughout the sugarcane area. It feeds some distance from the roottips and often on roots of considerable size. Affected roots become slightly swollen, have a spongy texture and turn brown.

(b) Spiral nematodes (Helicotylenchus spp.)

The spiral nematode constitute a group of closely related species. Several species are found throughout the sugarcane area of Louisiana. They feed with a long stylet from without and seldom actually invade the tissues. Their importance to other crop plants is significant but the amount of damage to sugarcane is not known.

(c) Ring nematodes (Criconemoides spp.)

This is an ecto parasite found in some sugarcane fields in small numbers. It is not considered as a serious parasite of sugarcane.

(d) Stubby root nematodes (Trichodorus spp.)

Not a great deal is known of the life history and habits of stubby root nematodes. They are strictly root tip feeds and cause a growth stoppage of root tips resulting in a stubby root system. At least 2 species occur in sugarcane fields of Louisiana.

(e) Tylenchus, Psilenchus, Dorylaimus and others.

The importance of these less prevalent forms are not known and little is known of their life cycle.

(f) Sting nematode (Belonolaimus sp.)

This is found only at Grand Isle, but produced severe weight losses to sugarcane in greenhouse tests.

NEMATOLOGY RESEARCH ON SUGARCANE

The nematology research on sugarcane is being conducted primarily as cooperative projects with the Department of Plant Pathology headed by

Dr. S. J. P. Chilton. Research personnel from the Plant Pathology Department active in this work include Drs. I. L. Forbes, R. J. Steib, Louis Anzalone, and Mike Giamalva. Growers active in this work include Mr. John Best of Port Allen, Mr. Gene Graugnard and Mr. Jim Graugnard of St. James, Louisiana. Dr. J. Pinkard of Shell Chemical has also contributed to this work. The research being conducted is of a fundamental and applied nature. A list of the projects appears below with a short summary of each.

1. Effects of methyl bromide on ratoon-stunting disease of sugarcane.

Plant nematode populations re-established rapidly in methylbromated plots and after May until October differences between treated and nontreated were not considered significant. RSD cane grown in methyl-bromated soil gave stand counts comparable to healthy cane grown in nontreated soil and increased the yields over nontreated RSD cane. The experiment was retained for a second year stubble and repeated in another field.

2. Nematode transmission studies of RSD and Mosaic.

(a) RSD virus - The sting nematode, *Belonolaimus longicaudatus*, and the ring nematode, *Criconemoides sp.*, were employed. Four transmissions took place where nematodes were involved. One apparent transmission was found where nematodes were not placed and 4 more where only healthy cane was planted in steam-treated soil. No transmission was observed in nontreated field soil and methyl bromated soil. Seed from all treatments are being maintained in the greenhouse in steam-sterilized soil.

(b) Mosaic virus - After a year final examination was made, greenweights recorded and this experiment terminated. Three transmissions were made where the sting nematode was involved. However, two transmissions occured under the same conditions without nematodes suggesting insect contamination. Greenweights and appearance of sugarcane grown in the presence of the sting nematode showed severe damage due to the parasite.

3. Catenaria vermicola - A nematode parasite in sugarcane soil. This fungus, which attacks and kills nematodes in sugarcane soil, was named and described with observations on its pathogenicity, host parasite relation, and life cycle. Growth studies on temperature, pH requirements, carbon, nitrogen and vitamin requirements are being made on the fungus. Efforts to successfully carry the fungus to the field in filter press or other substrates are being made.

4. Nematode control experiments in the field.

   (a) A field experiment in cooperation with Mr. John Best of Port Allen, Louisiana involved the use of emulsifiable nemagon placed on sugarcane at the time of planting at 1/4, 1/2 and 2 gallon rates per acre. Approximately 8 acres were involved with the experiment. Germination and early stands do not appear to be affected by any of the treatments.

   (b) A field experiment in cooperation with Mr. Eugene and Mr. Jim Graugnard of St. James, Louisiana was established with a new material called aqueline, introduced by Dr. J. Pinkard of Shell Chemical Company. The material was placed in furrow irrigation water as a preliminary trial. This material has nematicidal, fungicidal and herbicidal action. No damage to the sugarcane has been observed at the 5 gallons per acre rate.

5. Varietal tests of sugarcane for resistance to nematodes.

Four leading varieties of sugarcane are being tested for their resistance to population increase of 5 plant parasitic nematode species found in the sugarcane area of Louisiana. This experiment has only recently been established in clay pots under glass.

PILOT PLANT CLARIFICATION EXPERIMENTS WITH NEW CANES DURING THE 1960 SEASON

by

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Pilot plant experiments on clarification by simple liming, employing the standard procedure described in previous reports (1), were conducted at the Audubon Factory during the 1960 campaign with a total of 19 samples of unreleased and new commercial canes, and of the standard variety CP 44-101 used for comparison. Suitable cane in the quantities required for the experiments was furnished by the American Sugar Cane League who also provided for grinding of the samples in the Audubon Mill under the supervision of Mr. C. W. Stewart.

The only unreleased cane included was CP 53-1 which is the most promising of such canes available from secondary test fields and from Saint Gabriel Plantation; initial experiments with plant cane of the variety had given good results in clarification during the 1959 crop. Additional data were obtained on the processing of the recently released variety CP 52-68, and two experiments were carried out with plant cane of the long established variety CP 36-13, expanded cultivation of which is being considered.

The results of standard lime clarification of the juices obtained from these canes undoubtedly were affected by the conditions that prevailed during both the growing and harvesting of the crop, which differed from the normal pattern more than any encountered during the ten preceding years. The summer drought had severely retarded growth until September; thereafter, adequate

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1/ One of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.

rainfall brought about good recovery of the cane which was still growing and relatively immature even after the delayed start of grinding on October 25. The plant cane used in experiments on CP 36-13 and the unreleased variety CP 53-1 had been subjected to the first of the succession of freezes that began after December 1, but these and comparable plant cane samples of C P 44-101 had not been damaged severely.

The canes are rated as in the processing tests of 1959 and prior years (1), principally by comparison of the quantities of precipitate, i.e., the total underflow of the clarifier that must be filtered and recycled, and by the Luximeter clarity of the juices, with those obtained in clarification of the standard cane CP 44-101. Averages of the weights of clarification precipitate and clarities, together with other pertinent operating data and results for each experiment, are assembled in tables I and II. Results of the experiment, will be considered for each of the new canes separately, as it was not possible to conduct an equal number of tests with plant and with stubble cane of each variety, and some of the samples were obtained from plantations other than Saint Gabriel. The relative efficiency of simple lime clarification in processing the canes may be estimated by assigning to the average quantities of clarification precipitate produced a weight twine that of the clarity of the purified juices. Arbitrary assifment of these relative weights for calculating percentage ratings has been suggested (2), Because the increased costs of reducing grinding and processing rates to handle larger quantities of mud can be estimated, and are believed to be at least twice as great as losses from lower recoveries of raw sugar by crystallization from juices of poorer clarity.

C. P. 52-68

Three experiments were conducted with each kind of cane of this variety that is being planted on an increasing proportion of the total acreage. The results may be compared with those for plant and stubble cane of the standard C.P. 44-101 also from St. Gabriel Plantation. Lime clarification has never produced good clarities in defecated juices of this cane, and the average values of 28 for stubble and 24 for plant cane recorded in Table I were the lowest obtained for any of the varieties tested during the season. This disadvantage would by counterbalanced by the small amount of clarification precipitate obtained in processing the stubble cane samples, which averages only 117 lbs./T. cane compared to 155 lbs./T. for the standard as shown in Table II. Tests of the plant cane yielded an average of 167 lbs./T. slighty more than the amount produced by standard plant cane. The combined averages for both plant and stubble cane show that C.P. 52-68 during the past crop gave juices of clarity only 76.5 percent of that of the standard, but that it was 11.1 percent better than the standard in processing rate, based upon the quantity of clarification precipitate. The results are consistent with those obtained 20 tests of this cane during three previous seasons (2), which were 80 percent on clarity and 109 percent on processing rate. Combining the data from these tests with the averages of all previous tests of this cane give it a current rating of 79.5 percent of the clarity of C.P. 44-101, with an advantage of 7.5 percent in processing rate. Quality of the juice of this cane is practically equal to that of the standard cane for clarification if the rate at which it may be processed is assumed to be twice as important as clarity of the defecated juice.

C. P. 53-1

Clarification data were obtained for two samples of plant cane and only one of the stubble of this variety. The stubble cane was grown at St. Gabriel Plantation, but the samples of plant cane were furnished by the St. James Sugar Cooperative and results are not comparable with those for plant cane of C.P. 44-101 given in the tables. Only two preliminary experiments had been made during the 1959 crop using samples of plant cane of this variety from Smithfield Plantation, and its evaluation from the limited number of tests is tentative. The single test of stubble cane that may be compared with the standard yielded a clarity of only 31, and the unusually large quantity of precipitate, 170 lbs./T. of cane, would give a rating slightly less than 90 percent of the standard. While no comparison may be made with the C.P. 44-101, processing of the plant cane samples from the other plantations consistently produced small amounts of clarification precipitate. The defecated juices had an exceptionally high clarity of 57 during the 1960 crop, and satisfactory clarity of 32 in 1959. Plantings have been made for future experiments with comparable samples of both kinds of cane of this variety and of the standard, to establish its suitability for clarification. It may be expected to prove at least equal to C.P. 44-101 and C.P. 52-68 for processing by simple liming.

C. P. 36-13

Experiments were made with this established variety because with elimination of ratoon stunting disease, limited current commercial plantings may be expanded to replace mosaic susceptible newer introductions. Arrangements were made with Southdown Sugars Inc. to obtain two samples of plant cane of this variety and two comparable plant cane samples of C.P. 44-101 from New Hope Plantation. Juices of the standard C.P. 44-101 from this source gave excellent results with a minimum quantity of clarification precipitate and exceptionally high clarity after defecation. Compared with this standard, the clarity of only 36 recorded in Table I, together with the average of 142 lbs./T. cane of clarification precipitate in Table II would result in a very poor rating. Future experiments with stubble as well as plant cane will be necessary to determine the value of this variety for processing, as the results of only one pair of comparable tests with plant cane only must be regarded as tentative.

References

(1) Guilbeau, et al, Sugar Bull. 37(21): 274-283 (Aug. 1, 1959).
(2) Guilbeau, et al, Sugar Bull. 38(18): 226-233 (June 15, 1960).

Table I: Sugarcane Variety Processing Experiments - Average Juice Characteristics

Cane Variety	No. of Tests	Limed Juice pH	Defecated Juice pH	Defecated Juice Clarity 1/
lst Year Stubble Canes:				
C.P. 44-101	3	7.44	6.59	37
C.P. 52-68	3	7.42	6.59	28
C.P. 53-1	1	7.51	6.59	31
Plant Canes:				
C.P. 44-101	2	7.42	6.60	31
C.P. 52-68	3	7.33	6.62	24
C.P. 53-1 2/	2	7.69	6.59	57
C.P. 36-13 3/	2	7.36	6.59	36
C.P. 44-101 3/	2	7.46	6.58	56

1/ Adjusted to 14° Brix.

2/ Cane from St. James Sugar Coop., mechanically harvested and burned.

3/ Cane from New Hope Plantation, " " " " " " .

Table II: Sugarcane Variety Processing Experiments - Average Mud Characteristics.

Cane Variety	No. of Tests	Lime Used lbs./T. Cane	Insoluble Solids % of Mud	Wet Mud	Insoluble Solids Actual	Insoluble Solids Adjusted 1/
					Pounds per ton cane	
lst year Stubble Canes:						
C.P. 44-101	3	2.02	6.5	155	10.1	8.4
C.P. 52-68	3	1.80	7.1	117	8.3	7.5
C.P. 53-1	1	1.75	6.0	170	10.2	9.7
Plant Canes:						
C.P. 44-101	2	1.88	6.9	161	11.0	9.2
C.P. 52-68	3	1.55	6.5	167	10.8	9.2
C.P. 53-1 2/	2	1.14	10.2	128	13.1	8.0
C.P. 36-13 3/	2	0.98	20.7	142	29.4	7.6
C.P. 44-101 3/	2	1.00	10.2	122	12.4	8.8

1/ Adjusted to 1.0 pound field soil per ton cane, suspended in dilute juice.

2/ Cane from St. James Sugar Coop., mechanically harvested and burned.

3/ Cane from New Hope Plantation, " " " " " " .

DEVELOPMENT AND OPERATION OF THE RING TYPE PAN

by
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At 9:00 a.m., January 9, 1961, the operator pushed the "start" button on number four white sugar pan and stepped back to watch. Without any further action on the operator's part the pan raised vaccum, charged, grained, boiled and discharged a complete strike. It then flushed itself out with lube syrup and lit up the "end of cycle" light. Thus started the first week of fully automatic pan operation at Savannah Sugar Refinery.

I Histroy of Ring Pans at Savannah

Why did we buy a ring type pan? Savannah has two coil type pans on white sugar that are forty years old. They are due for replacement, so it was decided to investigate the claims of high yields of ring pans.

A single ring type low grade pan (1350 cu. ft.) was built and installed in 1951. We were able to boil a No. I Low Grade strike of 1350 cu.ft. in 1-1/2 to 2 hours. Strikes were boiled from magma footing and with seed-both results were good. Heavy boiling was done and was acceptable by test. The pan boiled No. 2's and No. 3's well, so a second ring pan was bought to replace an old calandria low grade pan. The first pan is now seven years old, and the second, three years old, and there has been no maintenance.

Before making the step to a white sugar ring pan with its heavy boiling equipment, we boiled white sugar on the low grade. Eight white pans were boiled in 1956, with 34 psi steam. Average steam flow was 35,000 #/hour, for 1400 cu.ft. of massecuite on a one hour cycle. Heat transfer rate for the series was 130. Pounds of sugar per minute of pan time was about 1,000. We could not drop a heavy strike but the pan gave satisfactory results on medium density.

In general, the advantages as we saw them were as follows:

1. The rugged design and open area of the heating section (72%) allow heavy density boiling. This type of strike can be expected to give 8 to 12% better yield.
2. Very low maintenance.
3. Good circulation on low pressure steam without the aid of mechanical circulator.

   The heating surface to normal massecuite level is 2510/1600= 1.57 on the new pan. We have good circulation on 15psi steam 6'8" above the ribbons. Boiling time is 96 minutes for 1600 cu. ft.
4. No steam out is required when the heating surface is flushed with lube syrup. Steaming out can use up to 1-1/2 lbs. of steam per 100 lbs. of white sugar depending on the sugar boiler.
5. Approximate cost (based on equipment only)

	HEAVY	Regular Calandria with 4", 10 gauge steel tubes
Pan	$ 68,500	$61,000
Mixer	$ 40,000	$27,000
Lube Tank	$ 4,000	-
	$112,500	$88,000

Extra equipment for heavy boiling is $24,500. This is a disadvantage, but it is hoped that better yield and fewer boilings will compensate for it.

II Pan Construction

Our new ring type pan is 14'-0" in diameter. All exposed surfaces above the heating elements are either stainclad or solid stainless steel. The heating surface is made up of ten concentric rings and on outside jacket on the side and bottom of the heating sections. All rings are of

5/8" type 285 steel plate with a 1/2" space is supported by top and bottom closing plates and 1700 welded studs on about 10" centers. Each ribbon has four 2"X3" support blocks which support and protect the ribbon where it rests on four heavy support brackets in the bottom of the pan. Steam inlet for each ribbon is a special 4" threaded nozzle which enters from the bottom of the pan. Condensate leaves through a similar 2-1/2" connection. Both connections can be broken and a ring raised for maintenance. All work must be done inside the pan for there is no provision made for the removal of a ring. The steam and condensate connections are the only fixed connections between the rings and the pan. The ribbon is free to expand. Spacing is maintained by four 2" x 1/2" x 3-3/16" long spacer blocks. There is very little buoyance due to ribbon displacement.

Non-condensable gas is removed from the rings through 3/8" standard brass pipes which extend up into the ring steam space. They all go into a header which drains to the condensate collector. A vacuum connection is provided to evacuate the rings on start up. White sugar pan ribbons are for working pressure of 85psi and hydrostatic test to 120psi.

Two 6 ft. belt sections of 3/4", 15% stainclad are welded to the mild steel bottom. These belt sections have eight 6" diameter sight glasses and a 20" quick-opening man hole. There are also connections for instruments, proof stick, etc.

The catch all or dome section is also 3/4" clad with a 5/8" clad cone top. All internal baffles are 3/16 solid stainless. The pan has a 36" vapor outlet, 6" vacuum break, two 20" manholes, plus misc. small connections in the dome section. There are two sight glasses high in the vapor space just below the catchall floor which provide a good view of the pan during boiling. Closed circuit T. V. was tried through these glasses but contrast was poor, due to lack of light. A 4" lube syrup ring is located under the catchall. We, at present, use it for steaming out, but in the near future, it will be used on saturated syrups.

Syrup enters the pan through twelve 1" x 2-1/4" slots in a ring around the foot valve, this seems to give good syrup distribution. Supplemental circulation is provided by an open steam coil. This is used for about 20 minutes during the cycle. The total circulation steam used per strike is 630 lbs. at 10 psi. Cost per year for all W. S. Pans is around $3,000.

Massecuite is discharged through a 36" foot valve operated by a 14" x 13" cylinder on 90 psi air. The large cylinder is locked in the closed position by a small air cylinder. The foot valve, therefore, cannot open on air failure.

The pan has a 72" solid stainless weir type condenser. The leg pipe is cast iron (16"). An individual V-belt driven vacuum pump is used which runs on high speed to evacuate the pan to about 20" of vacuum and then drops down to low speed. High speed, 300 rpm, takes 65 to 70 h.p. and low speed, 150 rpm, takes about 35 h.p. Piston displacement is 1700 cu. ft. per minute at 300 rpm. Vapor seal fiberglass 2" thick in 2' x 4' sheets insulate the pan.

All pan surfaces above the operator floor is covered with .040" stucco finish aluminum. About 1200 square feet of aluminum was used.

III Instrumentation

The control system was designed jointly by Baily Meter and Savannah Sugar. Through the use of some 25 relays, 12 solenoid valves, five timers and one programmmer, this system automates the beginning and end of a cascade pan control system that was proven through more than a years operation.

Pan is equipped with diaphragm valves for modulated syrup, steam and condenser water control. All other valves to pan including seeding valve are air cylinder operated.

The principle meters in the system are:

1. Sugar saturation
2. Mobility
3. Steam pressure
4. Absolute pressure
5. Tonnage (or level)
6. Steam flow
7. Absolute pressure program
8. Mixer (receiver) level

All control for the pan is centered in an 8 x 10 foot control room. Ultimately four pans will be controlled from this room. A 42 inch console contains on-off automatic switches for each valve on pan, indicators for each of the measured functions, timers, and automatic hand set point-hand valve loading stations for each controlled variable. An overhead diagrammatic panel above the console indicates the position of all the air cylinder valves. Primary pan control is of the sequencing type, wherein completion of each event or function initiates the subsequent one. For instance, the "start" button causes:

a. Vacuum break to close
b. Vacuum valve to open
c. Absolute pressure program to start.

Noting further happens until pan vacuum reaches a preset point and causes charge valve to open.

Secondary control is a "cascade" type with the tonnage controlling the set point of the steam pressure and mobility controllers. When the pan is charged to a preset point on the tonnage meter, the charge valve is closed and the cascade system is energized.

At a preset supersaturation: the seed valve is opened for a preset time, absolute pressure program is interrupted for a preset time, and circulating steam is opened for a preset time. After interruption, absolute pressure program raises pressure to boiling level and as evaporation continues, mobility of mass approaches set point and syrup feed commences. As pan level increases, tonnage meter raises set point of steam pressure and mobility controllers.

At a preset tonnage feed is shut off and as mass gets stiffer, steam flow decreases. At a preset steam flow steam, vacuum and condenser water valves are closed and dropping sequence is begun. Vacuum break is opened and then foot valve opens.

After timed dropping period a timed amount of lube syrup is sprayed in at the top of the pan to flush it out then foot valve is closed and locked and pan is ready for next cycle.

For safety, important valves are equipped with micro switches to indicate that they are in the required position or to interrupt the sequence if they are not. Thus, as precautions on the foot valve a micro has to indicate the vacuum break is open, a vacuum switch has to indicate no vacuum, another micro has to indicate foot valve lock is clear, and finally, a pressure switch on mixer level has to indicate enough room in mixer before foot valve can open. Another feature is that the seeding circuit is locked out by tonnage meter until pan is fully charged and supersaturation meter has settled out.

IV Operation

Number four pan was put in operation on number one strikes in January 1959. "High Density" strikes are standard procedure. A Dropping time of five minutes is considered ideal and dropping steam flow is adjusted occasionally to maintain this dropping time. Boiling time can be adjusted from 70 to 120 minutes to suit production needs. Number one syrup off previous strikes is used as "lube" syrup.

We have several slides:

1. Overall view of pan
2. Control room
3. Control room
4. Shows circulation stopped steam slow about 11,000#/Hr. at 25psi.
5. Foot valve open center starts moving out faster than rest of surface.
6. The massecuite is about 1/3 out and the center breaks away.

7, 8, & 9. Show the center clearing the pan and the heavy massecuite breaking off and falling into the down take.

10. The down take is clear with dry sugar in the ribbon.
11. Shows the massecuite clearing the ribbon section. No steam or lube syrup has been used. The dropping time is 14 minutes.

It was said that if the pan is dropped any heavier we will have to install a dust collector system.

THE USE OF GRANULAR ACTIVATED CARBON IN DECOLORIZING CANE SUGAR LIQUORS

by

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I. INTRODUCTION

Mr. Chairman, Members of the American Society of Sugar Cane Technologists, and Guests: On behalf of Pittsburgh Chemical Company I would like to thank you for the opportunity of appearing before your organization and presenting information on granular activated carbon. In this paper we will review the history of Pittsburgh Activated Granular Carbons in the refining of dextrose and cane sugar. The actual purification, reactivation, and conveying steps will be taken in turn with estimates given on the operating and installation costs for decolorizing cane sugar liquors.

II. HISTORY OF DECOLORIZATION WITH GRANULAR ACTIVATED CARBON

In 1941 the United States Armed Forces, fearing that their source of coconut shell, the raw material for activated carbon in military gas masks, would be shut off, approached Pittsburgh Coke & Chemical company, as well as other firms, requesting that research be initiated to develop a satisfactory activated carbon from bituminous coal. Our Company started work on this project, developed a successful activated carbon, and by 1945 was furnishing more than 85% of the Armed Forces' requirements. At the war's end, however, we found ourselves with a large carbon capacity but no market for it. We experimented with various types of pulverized carbons, selling quantities to the pharmaceutical and food processing industries, but in making our survey on the applications of adsorbents, we concluded that the corn sugar industry, where more than 100 pounds of bone char were being reactivated for every bag of sugar produced, would be an excellent market and the place where research should start. It was further concluded that if we could combine the very high activity of powdered carbons with the processing advantages of bone char, we could then offer a very efficient adsorbent and process.

A. EXPERIMENTAL DECOLORIZATION - CORN SUGAR

1. LABORATORY - ANALYZE CARBONS, BONE CHAR

As a first step in developing a satisfactory granular liquid phase carbon, we obtained samples of every adsorbent used in the corn sugar industry. Included were eight powdered carbons and two bone char samples. In cooperating very closely with Corn Products Refining Company and Clinton Foods Company, we asked that they advise us which carbons they preferred and which were optimum for removal of various impurities, such as color, protein, hydroxymethylfurfural and ash. With this information, we analyzed every carbon completely as to its characteristics and its structure, then attempted to produce a granular carbon which would contain the best properties of each adsorbent. After succeeding in putting these high activity characteristics in granule form, the mesh size was selected on the basis of pressure drop and decolorizing efficiency. The result was Pittsburgh Type SG 8x30 Mesh.

2. PILOT PLANT TRIALS - COLUMNS AT PITTSBURGH

This carbon was first tested in small laboratory and pilot columns at Pittsburgh. The information from these very brief trials was passed on to both Corn Products Refining Company and Clinton Foods, at which time Corn Products was so enthusiastic that they ordered an immediate plant trial in their Canadian plant at Cardinal, Ontario. This trial proved successful and resulted in an installation at Clinton Foods in less than six months followed by subsequent installations at Corn Products' plants at Pekin, Illinois in 1952; at Kansas City, Missouri in 1956; and finally at Argo, Illinois in 1958. In the first three installations, reactivation was attempted in normal bone char pipe kilns, but it was established immediately that this would not be satisfactory because good gas to solids contact for the oxidation of the impurities could not be obtained, nor could the temperatures needed for the reactivation be obtained. In each case, a Herreshoff reactivating furnace was installed. All of these plants now reburn five pounds of Pittsburgh Type SGL, or less, for each bag of dextrose. This is compared with a previous burn ratio of 100 pounds of bone char per bag of dextrose. In addition to this substantial reduction in costs, another advantage was the significant improvement in sugar quality.

B. EXPERIMENTAL DECOLORIZATION - CANE SUGAR

1. LABORATORY

With the initial success in the corn sugar industry, work was started on cane sugar. Batch and column decolorization tests were completed on sugar obtained from various refineries. We found that non-color impurities were not nearly as important with cane sugar as in the dextrose process and, therefore, a granular carbon with different adsorption characteristics would give better results.

At this point, we might use the simple analogy that activated carbon is like a sponge in that it is honeycombed with passageways or pores. To obtain different adsorption characteristics, we vary the number of these pores, or surface area, as well as the average diameter of the pores.

2. PILOT PLANT TRIALS

In 1952 a pilot plant test conducted at the American Molasses refinery in Brooklyn using the same Type SG Carbon confirmed our conclusions that a specific carbon for cane sugar would be needed. The subsequent introduction of Pittsburgh Type CA came in 1954. Our research group was simultaneously working on methods of improving our granular carbons and found that we could reduce the ash content from an average of 15% to less than 8% with a coincident improvement in hardness. This change was made in late 1954 and to indicate the improvement we redesignated both grades from SG and CA to SGL and CAL, the letter "L" indicating low ash.

3. PLANT TRIALS - REFINED SYRUPS AND SUGARS, HENDERSON SUGAR COMPANY, SOUTHDOWN, INC.

In our early work we noted that although decolorization equaled or exceeded our expectations, a problem was encountered on the long decolorization cycles with the pH of the sugar liquor, which dropped from 7.2 to as low as 6.1 with a resulting increase in invert sugar. A considerable effort was put forth to find some suitable means of controlling the pH at an acceptable level over the long decolorization cycles. While this work was proceeding, the management group of Refined Syrups and Sugars, Yonkers, New York agreed to full plant-size tests. For the experiment, 28,000 pounds of Pittsburgh CAL was placed in a standard cast iron bone char cistern. Sixty Brix liquor at 160°F. which had passed through a cistern of bone char was pumped over the CAL carbon at 60 gallons per minute. Pressure drop was less than 10 pounds. Nine million pounds of sugar were passed over the carbon with the average color reduced from 1.75 to 0.6 Horne. The pH of the effluent average 0.2 lower than influent and resulted in an increase in invert of 0.05%. Ash values of the product were equal to or lower than the feed. The second test was a duplicate of the first, but the third contained the pH control material found out by research group. This was dead burned magnesite which is mixed with the carbon on the basis of 5 to 10% by weight. The third test was a complete success as were all subsequent operations. In all of these experiments, the carbon remained on stream from 29 to 40 days.

In 1956 Henderson Sugar Company and Southdown, Inc. conducted pilot plant tests in column 2' in diameter by 20' tall using clarified liquor. These tests proved successful and provided sufficient data for both items to evaluate the economics of converting to Pittsburgh Granular Activated Carbons.

4. PLANT INSTALLATIONS - CANE SUGAR

Refined Syrups and Sugars have continued to use Pittsburgh Cal since their original tests in 1955. Industrial Sugars Inc. in St. Louis, Missouri converted to granular carbon for production of liquid sugars in 1956. They installed steel columns 9' in diameter by 10' high and operated 3 in series. American Molasses in Brooklyn, New York started using granular carbon in 1956. Both Henderson Sugar Company and Southdown, Inc. completed the transition to Type CAL in 1957 and 1958 respectively. It should be emphasized at this point that the latter two, Henderson and Southdown, are the only refineries which use granular carbon as their sole decolorizing agent. Inland Sugar in Chicago converted partially to Pittsburgh CAL as did California & Hawaiian Sugar Refinery in 1958 and 1960 respectively. A beet sugar refinery has been using granular carbon for the past two years and plans to install granular carbon in two additional refineries in 1961.

III. DECOLORIZING WITH PITTSBURGH TYPE CAL

A. Comparative Color Removal

As stated earlier, our aim in producing granular activated carbons was to combine the high activity of the pulverized carbons with the processing advantages of bone char. If CAL carbon is pulverized and compared with the standard powdered carbons on a batch basis, we find the color removal efficiencies to be at least equal.

At Southdown, Inc. the burn ratio, or pounds of CAL carbon reactivated per bag of sugar produced, is 0.7 to 0.8. This is higher than the 0.35 to 0.5 pounds of powdered carbon used previously, but it must be remembered the granular carbon is still removing 85 to 90% of the color when it is taken from service and reactivated. Decolorizing cycles are 18 to 28 days.

B. pH Control

For controlling pH, we recommend adding 5 to 10% dead burned magnesite to the granular carbon as it is used in the columns. This granular material, which is largely magnesium oxide treated at very high temperatures, is mixed intimately with the carbon and succeeds in controlling the pH over extended decolorizing cycles. Experience since its introduction has shown that it will reburn during reactivation along with the carbon. Additional magnesite is used in the same proportion when adding make-up carbon or when ever the pH of the sugar liquor indicates a need for it. This normally requires 1% every sixth to tenth cycle.

C. Ash Removal

Because of the very high carbon content and the very low mineral content, which are 92% and 8% respectively, the granular carbon has little or no capacity for ash removal. In certain large scale tests we have attempted to make an ash balance and in the case of Refined Syrups and Sugars, we have calculated that a filter of granular carbon will remove almost as much ash as a filter of bone char. The latter, however, is done over a normal period of three days, while the granular carbon cycle will last as long as 30 days. Therefore, 27 days of ash go through the filter untouched. For practical operation we can say the ash will neither increase nor decrease when passing over CAL carbon.

IV. REACTIVATION OF GRANULAR CARBON

A. Mechanism of Regeneration

The mechanism of reactivation of granular activated carbon can best be described by pointing out that each granule, being porous, becomes saturated with color molecules and other impurities. The function of reactivation is preferentially to burn these color bodies away from the base carbon. Every 100 pounds of granular carbon may have as much as 25 pounds of impurities adsorbed on it. This is the reason that much higher temperatures are required than with bone char reactivation, as well as a controlled atmosphere of steam and combustion products. You can readily see that to withstand this severe treatment on an economical basis the adsorbent must have sufficient hardness to withstand the handling and must be refractory in nature so that it will resist burning. Carbon losses in present installations average 3 to 7% per cycle.

B. Equipment - Rotary - Herreshoff

The equipment recommended is a direct fired rotary kiln or a Herreshoff furnace. Both of these units are used currently in installations and can be designed to burn either fuel oil or natural gas. Temperatures normally maintained in the actual reactivating zone are 1750 to 1850°F. The rotary furnaces vary in size from 24" in diameter by 12-1/2' in length to 6' in diameter by 50' in length. Herreshoff furnaces vary from 3' in diameter with 6 hearths up to 16' in diameter with 7 hearths. Either of these furnaces can be designed for a specific installation.

C. Handling and Cooling - Tube - Screw - Quench

The spent carbon can be fed into either furnace by conventional conveying equipment. In the case of a rotary furnace, the normal method uses a screw conveyor, a belt conveyor with a feed chute, and in one or two cases, a star feeder through a feed chute. The normal controlled feeding device for the Horreshoff furnace is a star feeder.

Although there are many types of indirect coolers available, such as tube cooler and conveyor cooler, most refineries have found it more economical to let the carbon drop from the furnace immediately into water for quenching. In spite of this harsh treatment, both laboratory and plant experience have shown that this has not contributed significantly to carbon losses.

V. CONVEYING GRANULAR CARBON

A. Mechanical - Screw - Vibrator - Bucket

Granular carbon can be conveyed mechanically or hydraulically from the decolorizing columns to the reactivation site. Screw conveyors, frequency vibrating conveyors, and bucket elevators are all currently used in the mechanical handling systems. Losses using these devices for conveying carbon are in the same order of magnitude as those with hydraulic conveying.

B. Hydraulic

When carbon is conveyed hydraulically, it can be either pumped through a diaphragm or centrifugal slurry pump, be circulated with the use of an eductor, or air pressure can be applied to the top of the carbon-water slurry, forcing the slurry to the spent carbon hopper. Again, all have proven satisfactory and no significant change in carbon loss or maintenance costs have been determined from one to the other.

C. Pneumatic

Pneumatic conveying of dry carbon has been tested and it has been shown that the granular carbon breaks down excessively in these systems.

VI. OPERATING COSTS

For the purpose of estimating operating costs for a granular carbon installation we have listed below the estimated costs of a refinery with a melt capacity of 2,000,000 pounds per day. These estimates are based on the averages of several operating installations. For this melt and a 0.7 pound burn ratio 14,000 pounds of CAL carbon must be reactivated per day.

Fuel and Maintenance Cost for Reactivation	- 0.5 cents per Bag of Sugar
Carbon Losses	- 1.0 cents per Bag of Sugar
Filter Aid	- 1.2 cents per Bag of Sugar
Labor (Includes Maintenance)	- 0.6 cents per Bag of Sugar
Total Cost per Bag of Sugar	- 3.3

We feel this cost to be lower than any other method of decolorizing cane sugar.

VII. INSTALLATION COSTS

The equipment needed for any granular carbon installation for refining cane sugar would involve columns, reactivating furnace, spent carbon tank, dewatering screen, and pumps for conveying the carbon. For a refinery of 2,000,000 pounds per day, our best estimates for the installed cost of this equipment are as follows:

8 Columns (10' x 25')	$40,000
Reactivation Furnace	45,000
Pumps (3)	3,000

Dewatering screen	$ 2,000
Spent Carbon Tank	1,000
Building Space	30,000
Pipes, Valves, Other Accessories	30,000
TOTAL	$151,000

It is assumed that all refineries converting to granular carbon would have adequate pressure filtration capacity. The installation should be paid for with the savings in less than eighteen months.

VIII. FUTURE WORK

We have presented here our experience in this area and want to assure you of our continuing interest in improving the decolorizing operation in cane sugar refining. We certainly thank all the refineries who have worked with us in the past and especially Mr. A. J. Isacks and Mr. Carroll Dupuy of Southdown, Inc., Mr. William McFarland and Mr. Joe Metzler of Henderson Sugar Refinery, Mr. Dwight Gillette and Mr. R. D. McKeller of Refined Syrups and Sugars, the technical personnel of California & Hawaiian Sugar Refining Company, and all of the other refineries who have been of invaluable assistance. We are working and will continue to work toward improving our adsorbent and the techniques for applying it, as well as more efficient methods of handling and reactivation. If there are any questions, I certainly would be most happy to answer them.

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NEW CANE MUD FILTRATION PROCESS AT CALDWELL

by
-- H. V. Miles [1] and L. Aconsky [2]

During the past grinding season, the new Cane Mud Filtration System developed by Dorr-Oliver was demonstrated for the first time in a Louisiana mill at the Caldwell Sugar Factory. It represented the second successful installation of the new process known as the Rapi-Floc Filtration System - although since then, the third installation in Puerto Rico has started up successfully. There are now a total of five Rapi-Floc filters in operation and a number of factories over the world are contemplating installations for the coming grinding seasons.

What is the Rapi-Floc System? Briefly, it is a coagulation process that enables the conventional Oliver with slight modification to deliver a clear filtrate. The surprising thing is that it does this at about double the capacity of the regular filter. This increase in capacity combined with a clear filtrate has been achieved simply by altering the size and shape of the mud flocs. Without agglomeration, the mud solids, comprising particles predominantly in the 1-10 micron range, form a tight cake of low permeability when contained on a closely woven filter cloth. The filtration rate is low and adequate cake washing is almost impossible to achieve. In view of this, there was an apparent need for changing the filterability of the mud. Since it could be accomplished by coagulation, a painstaking coagulation study was undertaken to explore the possibilities. During the course of this

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work, a simple but rather unique method of coagulation was found to produce large agglomerates from the fine cane mud solids. Figure I shows a photograph of mud solids before and after coagulation. Obviously, the large flocs suggest that it might be possible to filter such mud direct on a rather porous medium and still obtain a clear filtrate. This was the beginning of the Rapi-Floc Filtration Process.

RAPI-FLOC PROCESS

The Rapi-Floc Filtration Process comprises the following elements:

A. Coagulant dissolving and supply system.
B. Lime Feeder
C. Mud Coagulator
D. High Porosity Filter Medium
E. Continuous Cover Wash

The manner in which these elements are applied to the conventional Cachaza filter is shown on the flow sheet in Fig. 2.

Basically, the system comprises lime addition to the mud in the mix tank followed by coagulation with a polyelectrolyte in a specially designed coagulator (C). The coagulated mud then flows by gravity to the filter tank. The modifications to the filter itself are rather simple comprising.

1. A cover wash shower with scraper assembly
2. A compact, free-flow valve
3. A special filter fabric installed over the existing perforated screens

The auxiliary equipment comprises a small lime feeder, a pH meter and a coagulant dissolving and supply system. The latter is designed to serve the entire filter station although a separate coagulant supply pump and dilution system is recommended for each filter in order to provide the maximum flexibility in operation.

A. Coagulant Dissolving and Supply System

The design of the coagulant system is shown on the flow sheet. It is generally sized to handle the requirements of at least two or more filters. A typical system will have tanks of 250 - 275 gallons capacity, so that solution need be prepared only about once every 6 - 8 hours.

Dissolving of the coagulant (Separan AP-30) is almost automatic with the use of a vibratory feeder and a disperser for pre-wetting the Separan prior to solution mixing. In this way, coagulant clumping is avoided so the solution time is kept at a minimum. A batch of coagulant solution can thus be easily prepared in 30-40 minutes at the most.

The solution is prepared at a high concentration (0.5%) to minimize the size of the tanks. For efficient coagulation however, dilution to .05% is required and this is achieved by means of a pipe line dilution mixer with a rotameter for regulating the dilution flow. The supply pump is a plunger type with adjustable stroke for adjusting the coagulant feed as required.

B. Lime Feeder

The addition of lime slurry to the mud is generally accomplished with a small pump having an adjustable pulley arrangement for easily varying the rate. The lime supply is drawn from the circulating system and a small sump box with overflow and drain is employed as a low head supply for the pump.

C. Mud Coagulator

After addition of the bagacillo and lime to the mox tank, the mud is pumped or flows by gravity to the coagulator where the coagulant is added. A special type of coagulator had to be developed in order to attain the high coagulating efficiency required for the success of this method. If even a portion of the solids were to remain unflocculated, the quality of the filtrate from a solids standpoint would obviously be affected.

To provide efficient coagulation, the coagulant must be introduced into the mud at a number of points as otherwise, the coagulant molecules never reach all of the particles so complete flocculation does not result. The D-O coagulator accomplishes this in a special design that provides the dispersive and swirl action necessary for effective agglomeration. It is the heart of the system. Its effectiveness is measured by the clarity of the filtrate.

D. High Porosity Filter Medium

With the formation of large agglomerates from the fine cane mud particles, a very porous fabric can be employed to secure a clear filtrate. To illustrate, the type of cloth used in the Rapi-Floc process has a porosity rating of 250-280 cfm/sq ft/0.5" water pressure drop. Obviously, a cloth of this porosity is less susceptible to blinding and, therefore, capacity is more likely to be maintained.

The Dacron high porosity filter medium is applied over the existing perforated screens and held in place with Acme bands. The lap joint is sealed with a special adhesive. On the average, 3 1/2-4 hrs. is required to install the filter media. With the cloth now serving as the filter medium, cleaning and replacement of the perforated screens is essentially eliminated.

E. Continuous Cover Wash

As the cake is discharged from the Rapi-Floc filter, some solids remain on the media. These are continuously removed by a cover wash spray located under the scraper. The arrangement of this cover wash and scraper combination is shown in Fig. 3. The spray nozzles are the flat jet type having a high inpingement action for effective cleaning. At 40 psi pressure, the water consumption is 3.0gpm/ft. of face width. Thus, for a 12 ft. face filter, 36 gpm is required.

The water is diverted to the collecting trough so it can be sent to waste or out with the cake. To prevent this wash water from entering the filter vat, a rubber seal strip is provided between the trough and the drum.

THE CALDWELL OPERATION

The Caldwell factory has an average grinding capacity of 2800-3100 tons/day with a peak grinding rate of about 3700 tons/day. The defecation equipment comprises three clarifiers ranging in size from 24-28 ft. in dia. The filter station consists of two 8x14 conventional mud filters.

The mud load at Caldwell is generally heavy, averaging around 95 - 100 lbs. of cake per ton of cane. With this load, the filters must average around 15 - 18 lbs./sq. ft/hr. To attain this capacity, the filters must be operated at maximum speed and consequently, higher sucrose losses result. During rainy periods when mud loads are even higher, the filters cannot handle the load. This, coupled with the high circulating load of solids contained in the filtrate causes the mud level in the clarifiers torise with an adverse effect on overflow clarity. It has generally been necessary then to cut back on production. The average grinding rate in recent years is shown in Table I. Of course, as you all know, other factors besides the capacity limitation of the filters and clarifiers enter into the factory performance as a whole. But it is fair to say that this has been one of the principal capacity limiting factors. As will be noted, there was about a 11% increase in the grinding rate over last year and about a 16.5% increase over the average grinding rate for the past six years.

RAPI-FLOC INSTALLATION

Prior to the start of this past grinding season, it was decided to convert one of the two filters to the Rapi-Floc system so the filtrate from at least one unit could be sent direct to the evaporators. In addition, it was hoped that theadditional capacity to be expected from the Rapi-Floc unit would help to keep the mud from accumulating in the clarifiers as previously experienced during rainy periods or when higher grinding rates were attempted.

The coagulator was installed at the rear of the filter as shown in the photograph Fig. 4. The flow to the unit was regulated manually. Coagulant was pumped to the coagulator with the feed line going through a hollow shaft in the gear motor drive.

The coagulant dissolving and supply system was installed adjacent to the filter on the same level. It is shown in the photograph Fig. 5. A platform and stairs were installed by Caldwell to facilitate charging Separan into the feeder hopper. The lime pump with its variable speed drive was mounted on the front of the supply tank for reasons of convenience and accessability. The lime was fed to the mix tank located on the floor below.

Cover wash and scraper assembly is readily mounted on the tank. It can be partially seen in the photograph Fig. 6. showing the filter in operation. Note the clean appearance of the filter media when the cake is removed. This is characteristic. It readily separates from the media unless the bagacillo addition is cut way down.

The conventional valves are replaced with a compact, free-flow type in order to handle the much great flow. This valve is interchangeable with the standard Oliver valve so it is a simple matter to install as both are designed for center stem mounting.

Performance Results

The Rapi-Floc filter was started up on November 2, some 48 hours after grinding began and operated continuously for the entire grinding season with a total out-of-service time of less than 10 hours. The actual grinding time was about 990 hours. In other words, the total downtime was on the order of 1%.

During this period, the filtrate was sent direct to the evaporators since it was always of acceptable clarity according to Mr. Bailliet, the factory manager. In capacity the filter exceeded expectations, even more than doubling that of the conventional unit. Mr. Bailliet stated that "the filter handled 75% of the total mud volume during this grinding season." The capacity ranged from 12,000 - 22,000 lbs/hour depending on the feed solids concentration and the drum speed. On a rate basis, the Rapi-Floc filter showed capacities usually around 40 lbs./sq. ft/hr. with maximum of 60 lbs/sq. ft. The conventional filter was operated at a rate of 10 lbs./sq. ft/hr. although this could be increased somewhat with a faster drum speed.

After about 10 day's operation, the mud level in the clarifiers was down to such a low point that Dr. Keller recommended liquidating one of the clarifiers. This was done to determine if an increase in purity could be obtained by the reduction in retention time. According to Mr. Bailliet, a slight purity rise of 0.3 was noted during this period.

The average cake sucrose losses were reduced from 4.98 - 4.21 over the previous year. Past experience with the Rapi-Floc filter in Puerto Rico showed that cake sucrose losses in the 2-3% range were readily obtained at rather fast drum speeds (3.5-4.0mpr.) Consequently, we would expect the sucrose values to be brought down to this range. At Caldwell this year, a shortage of vacuum and evaporator capacity greatly limited the operation of the filters for efficient washing. In addition to this, the Rapi-Floc filter was operated at drum speeds up to 3 mpr. where it is difficult to attain sucrose values below about 3%. Mr. Bailliet plans to convert the second filter this year so that both filters can be operated at lower speed with more wash flow in order to secure lower sucrose values.

One of the surprising results was that the filter cloth lasted the entire campaign without any significant blinding as capacity remained at a high level. In fact on November 28, after 26 days' operation, the data shows a capacity of 60 lbs/sq. ft/hr. One section of filter cloth did show blinding during this period but a high pressure wash for a few minutes quickly remedied the condition. Since the use of a synthetic non-woven filter medium on the Rapi-Floc filter is more economical than synthetic woven fabrics, the exceptionally long life only adds to the attractiveness of the process.

Test Data Summary

A summary of the test data obtained on the Rapi-Floc filter is shown in Table II. As will be noted, the filter was operated at drum speeds within a 3-4 mpr range and at vacuums of 15-18" Hg, although the final dry vacuum was often at 5-10" Hg. The maximum capacity of about 62 lbs/sq. ft/hr. was obtained at the 3 mpr.drum speed. However, with the small amount of wash water that could be applied to the cake at the reduced vacuum on the final dry stage, sucrose losses at this operating speed were high (about 5%). With an increase in the wash rate and a decrease in drum speed to 4. Ompr. the cake sucrose was 3.0%. Based on our experiences in Puerto Rico, it is our feeling that cake sucrose losses can be reduced to between 2 and 3% when additional cake wash water is available. At a 4 mpr. drum speed, a capacity of 40-45 lbs/sq. ft/hr. would be obtained on the basis of our data.

The filtrate solids fall within the range of usual clarifier performance, varying from about 0.05% to 0.32% by volume. The filtrate was sent direct to the evaporators and the factory reports that no adverse effect on the fouling of the evaporators was experienced even though the pH was increased for efficient flocculation. For the most part, the pH of the filtrate was maintained at a 7.0-7.5 level with satisfactory clarities being obtained at all times. The relation between filtrate solids and mud pH is shown on the graph Fig. 7. Note how sharply the filtrate solids drop with only a slight increase in the mud pH. The purity of the filtrates range from 70-76 with the majority in the 73-74 range. This compares favorably with the 76.69 average purity of the clarifier overflow for the season.

The brix of the first filtrate which represented the bulk of the flow was generally 10-11°, about what we expect for mud filtrates. The lower brix of the much smaller second filtrate reflects the effect of the wash water.

Filter Cloth Life

The special Dacron filter cloth did not require changing during the grinding season that ran for 45 days for a total of 990 grinding hours. It was expected that the cloth life would probably not exceed 30 days so this additional service came as an extra dividend. The cost of this fabric is quite reasonable, running about $150 for an 8 x 14 filter.

Chemical Costs

The two chemicals used in the Rapi-Floc process are lime and the Dow Chemical Company polyelectrolyte AP-30. The lime consumption is very nominal since only a slight adjustment in pH is necessary. The flow was generally about 0.5 gpm of 5 Baume slurry. The AP-30 was fed at a rate of 34-40 gph (0.5% solution) which is equivalent to 34 - 40 lbs/day. The total coagulant consumption for the season was 1150 lbs. A cost summary for lime and Separan is shown in Table III.

As will be noted, the lime dosage is very low, about 0.1 lb. as $Ca(OH)_2$ per ton of cane at a cost of a little over 0.1 cent/TC. The coagulant cost is also moderate considering the mud load. The total chemical cost of 1.43 cents/TC is within our original estimates of 1-2 cents/ton of cane for the majority of factories.

ECONOMIC ASPECTS

In any process change, the benefits must obviously exceed the added costs. With the Rapi-Floc filtration system (Fig. 8) the costs are readily calculated. However, the benefits are only indicated from factory operations. In addition, the amount of any betterment in manufacturing that can be attributed to the process is quite difficult to evaluate as we all recognize. Yet, it is necessary to assess the economic benefits to the best of our ability to judge for ourselves if the cost is justified.

What are the potential benefits from the Rapi-Floc filter operation? You can best answer this for your own factory but we can propose what clear filtrate and greatly increased filter capacity might mean for any factory.

1. Increased grinding rate
2. Elimination of lost production due to decrease in grinding rate during rainy periods
3. Higher quality sugar during periods of heavy mud loads
4. Increased clarifier capacity
5. Reduction in clarifier juice detention time
6. Lower sucrose losses in mud
7. Less evaporator tube fouling during periods when clarifiers are over loaded.

An estimate of potential savings can be made for some of the above benefits. If the grinding rate is increased 11% as was possible at Caldwell this year, it would represent a reduction in the production cost from about $1.00 to 0.90 per ton cane or a saving of about 10 cents/ton cane. Thus, in about 5 days, the savings would pay for the chemical cost.

If, during the rainy season, a heavy mud condition caused suspension of operations, even one hour's lost production would represent a considerable monetary loss as you all well know. For Caldwell, one hour's production means a grinding loss of 142 tons of cane on the basis of this year's grinding rate. This represents an increase of about 5 cents per ton of cane for the day's operation.

A higher quality sugar during periods of heavy mud loads also represents a dollar benefit but we do not have any specific figures to show for this.

The increase in clarifier capacity could be as much as 20-25% since this represents the average amount of recirculated filtrate from conventional filters. If the clarifier station was a limiting factor in increasing production, a considerable benefit could be realized especially when the filtration system also provides increased capacity.

A reduction in clarifier retention time may result in some slight increase in purity. At Caldwell this past season an increase of about 0.3 in purity was noted when one clarifier was liquidated.

With a more permeable cake and a better cake washing system, lower sucrose losses are possible. A decrease of 1% in the cake sucrose represents a potential recovery of additional sugar equal to about 5 cents/ton of cane. Here again the savings in this area along are substantially more than the chemical costs for the filtration process.

If evaporator fouling can be lessened through elimination of cloudy overflows in periods when clarification facilities are overtaxed, savings in chemical costs, better evaporator performance, etc., may be realized.

From the foregoing, it is thus obvious that the potentional savings may be substantial when the Rapi-Floc filter system replaces the conventional mud filters.

OVER-ALL BENEFITS

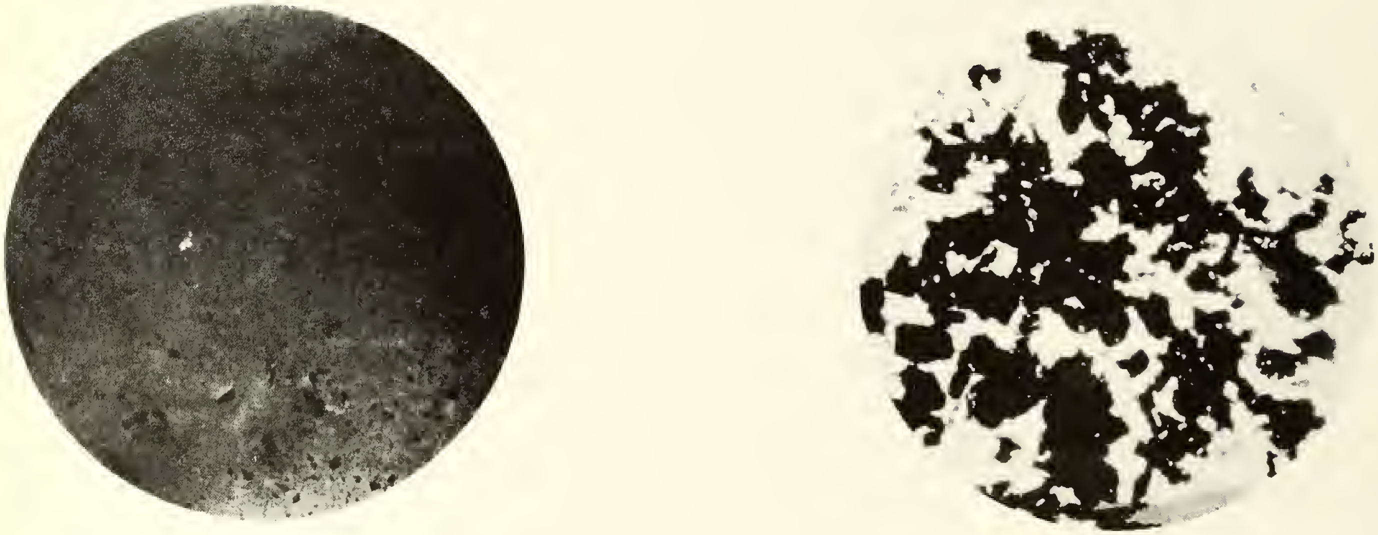
Even with only one of the two cane mud filters converted to the Rapi-Floc system during the past season, the Caldwell factory was able to observe specific benefits in their operations.

In the words of their factory manager, the results may be summarized as follows:

1. The Rapi-Floc filter handled at least 75% of the total mud volume during the grinding season (equivalent to 2349 tons cane/day, as against 1400 tons before conversion.)
2. A slight rise in purity of 0.3 was obtained when it became possible to liquidate one clarifier.
3. The main advantages were in increasing and maintaining the grinding rate in any mud condition.
4. They always had clear, clarified juice and consequently, improved their pan work which resulted in a better sugar quality in adverse grinding condition.
5. The filtrate juice was always of such quality to permit it being sent directly to the evaporator supply tank. No adverse effect was observed in fouling of evaporator from the slight increase in alkalinity.

In conclusion, Mr. Bailliet states that they are so pleased with the operation of the converted filter that he plans to convert the second filter for the coming season.

FIG. 1
CANE MUD SOLIDS
BEFORE & AFTER COAGULATION

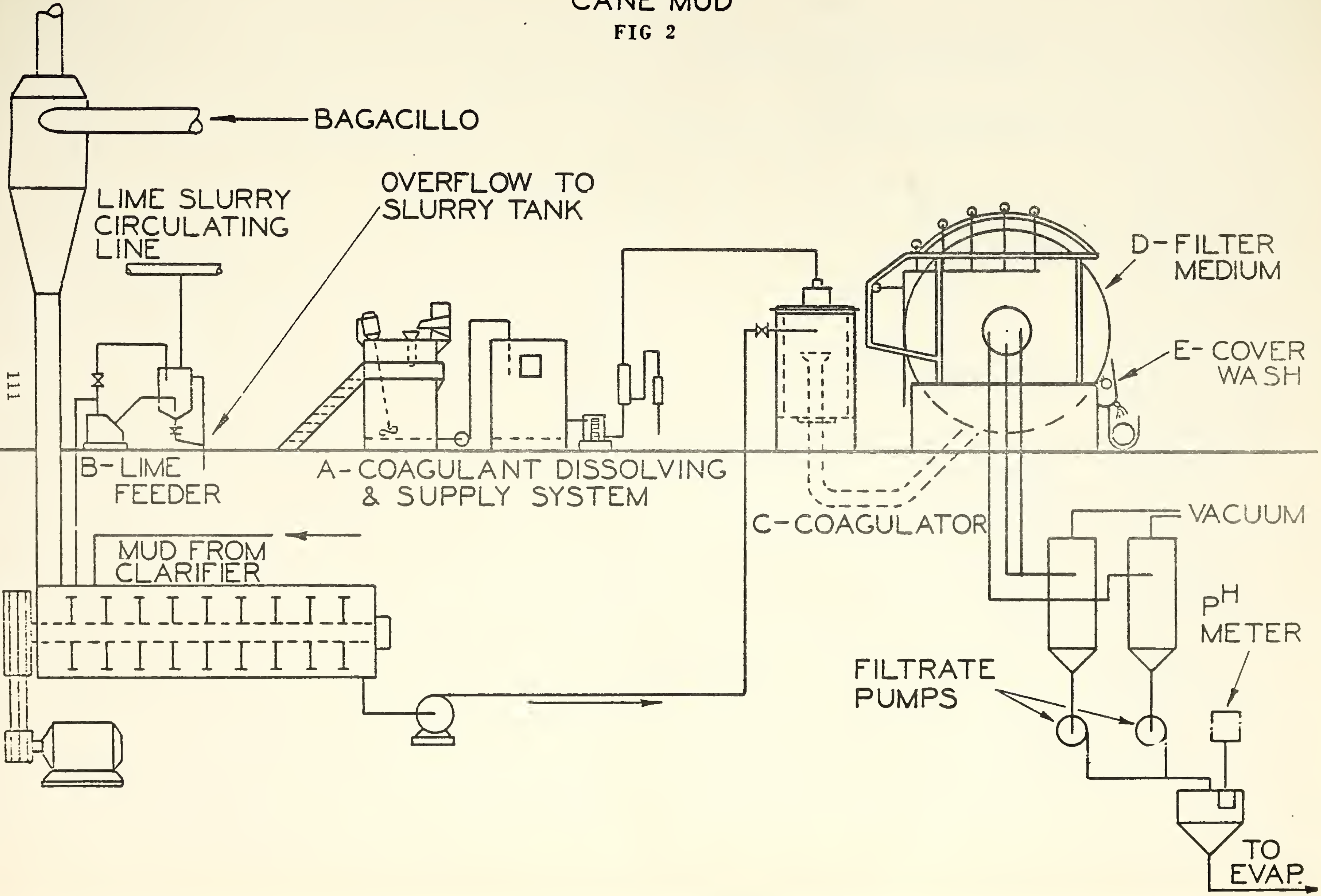


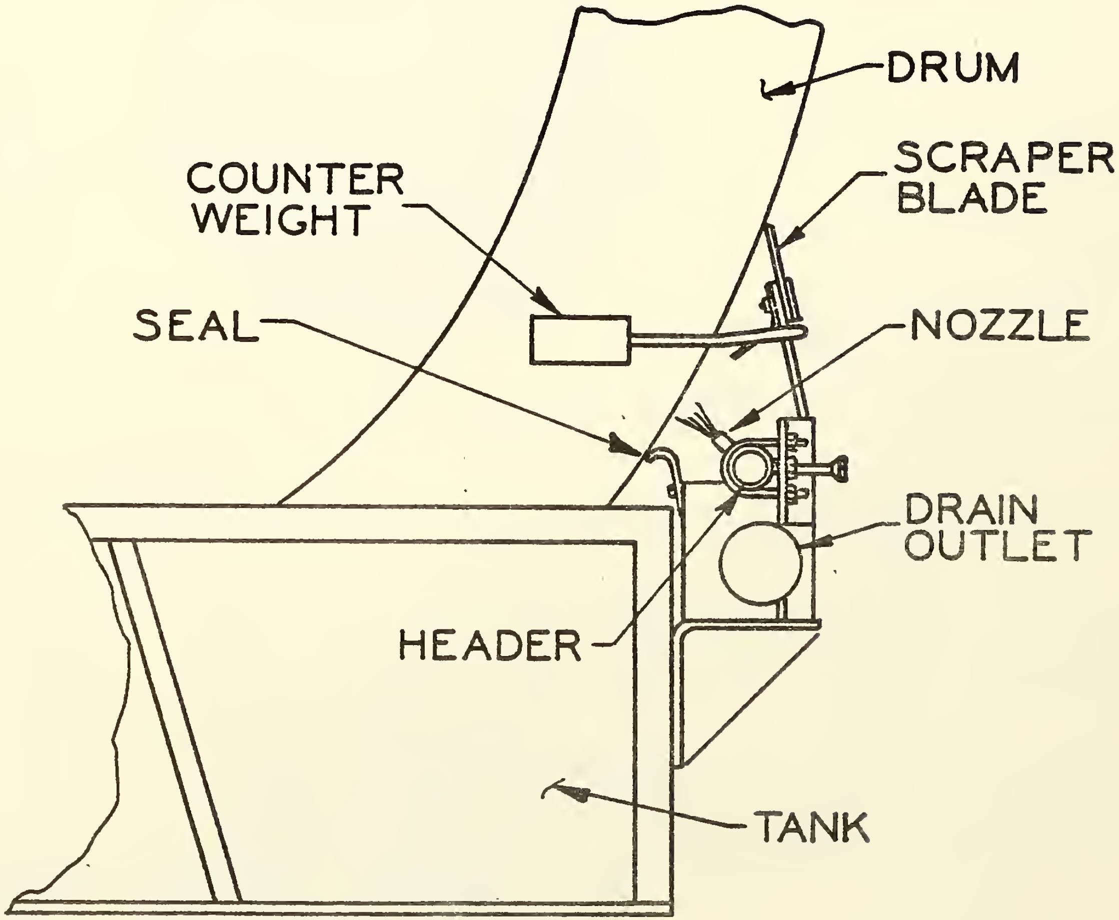
CANE MUD SOLIDS
NORMAL FILTER FEED

CANE MUD SOLIDS
AFTER RAPI-FLOC TREATMENT

RAPI-FLOC FILTRATION PROCESS FOR CANE MUD

FIG 2





COVER WASH SHOWER
FOR
RAPI-FLOC FILTER

FIG 3

TABLE I

CALDWELL MANUFACTURING DATA

Year	Cane Ground Tons	Grinding Rate-T/Hr	Lost Time Mud-Hours	Mud Total Tons	Mud Pol.
1960	141,606	142.7	0	6,729	4.21
1959	117,420	129.1	0.67	4,679	4.98
1958	137,393	126.4	2.0	4,179	4.8
1957	140,967	94.5	14.1	-	5.48
1956	116,847	112.5	1.7	3,609	4.97
1955	149,733	116.1	5.9	5,503	5.22
1954	150,882	118.1	15.2	5,265	5.04

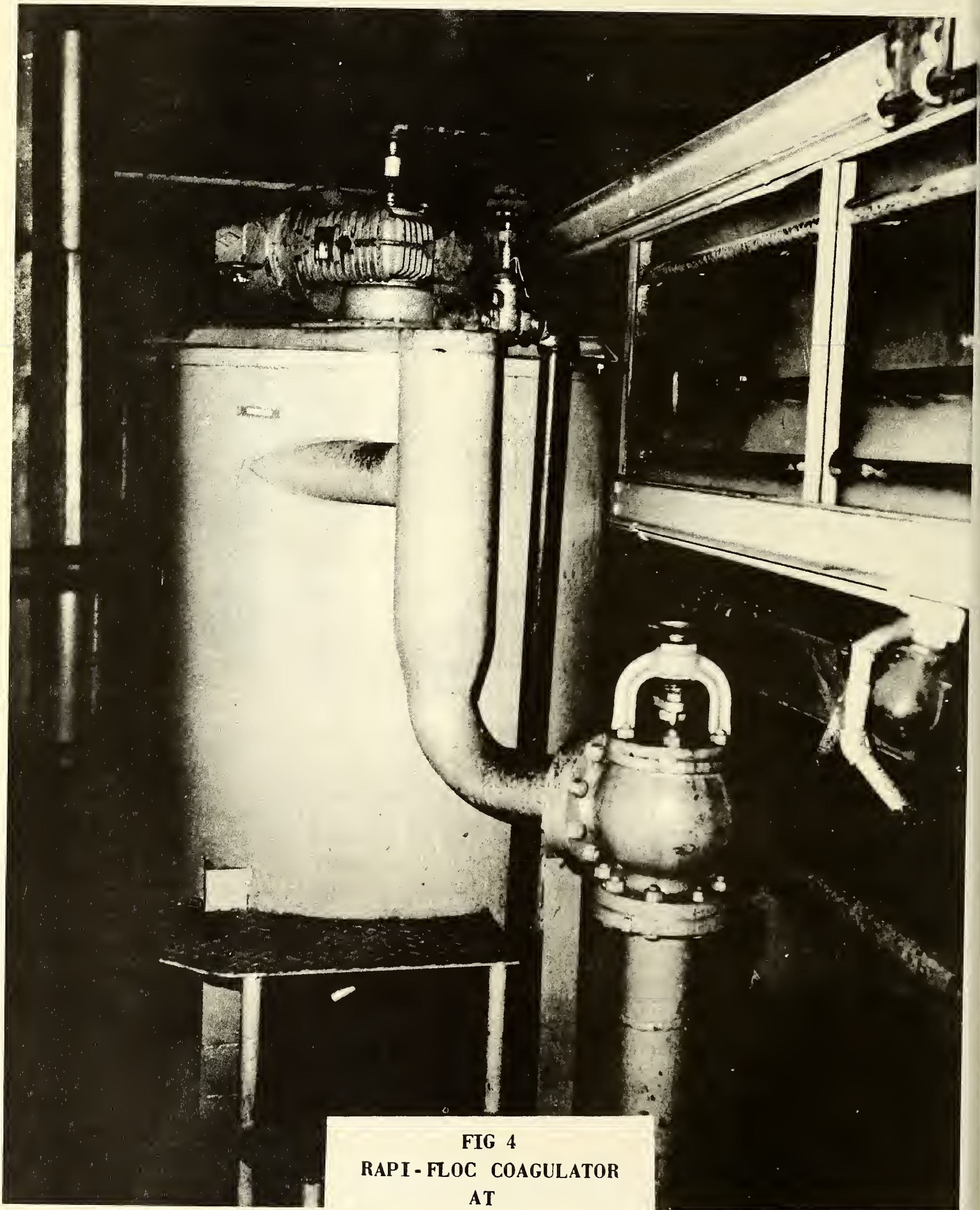


FIG 4
RAPI-FLOC COAGULATOR
AT
CALDWELL SUGAR CO-OP

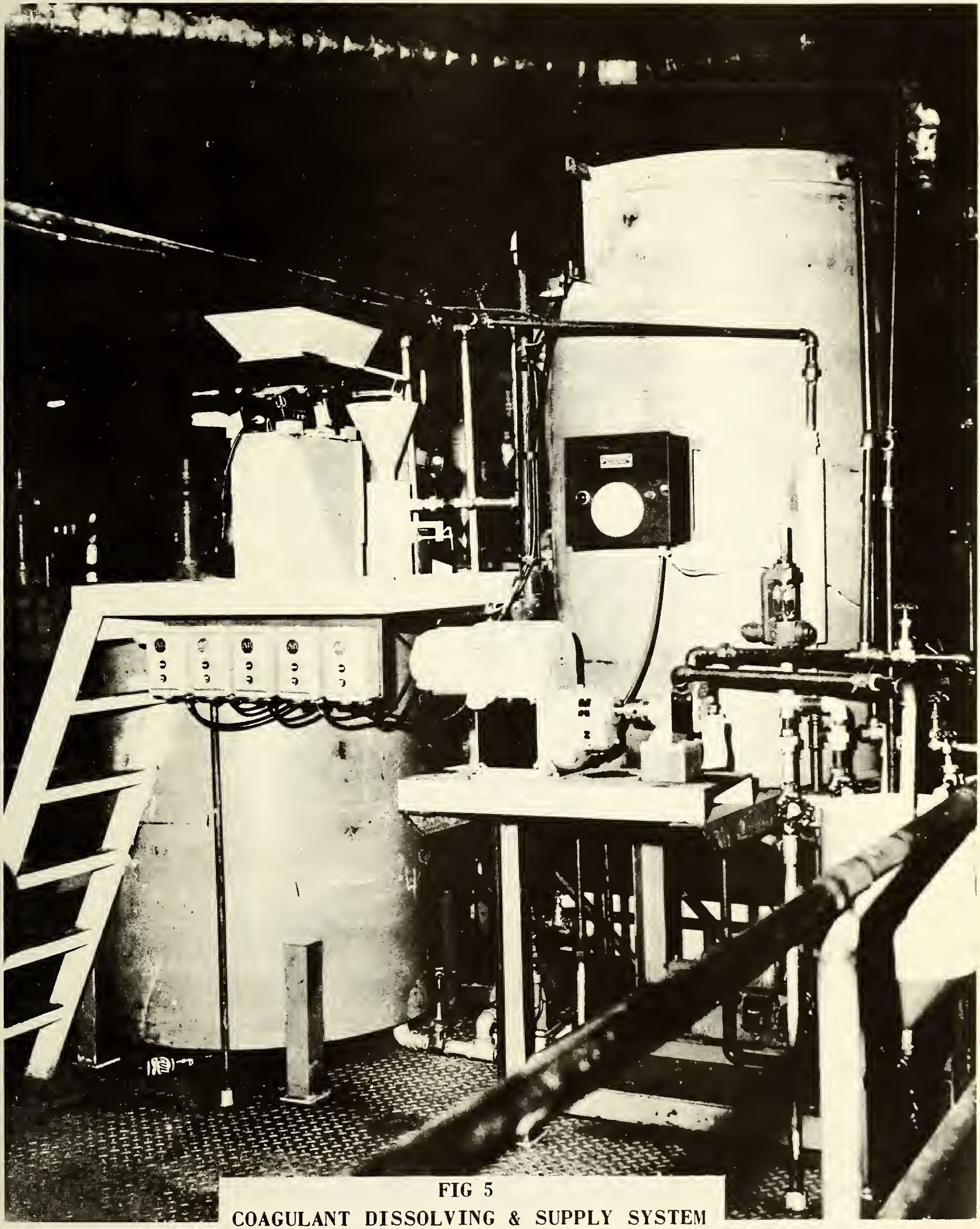


FIG 5
COAGULANT DISSOLVING & SUPPLY SYSTEM
CALDWELL SUGAR CO-OP

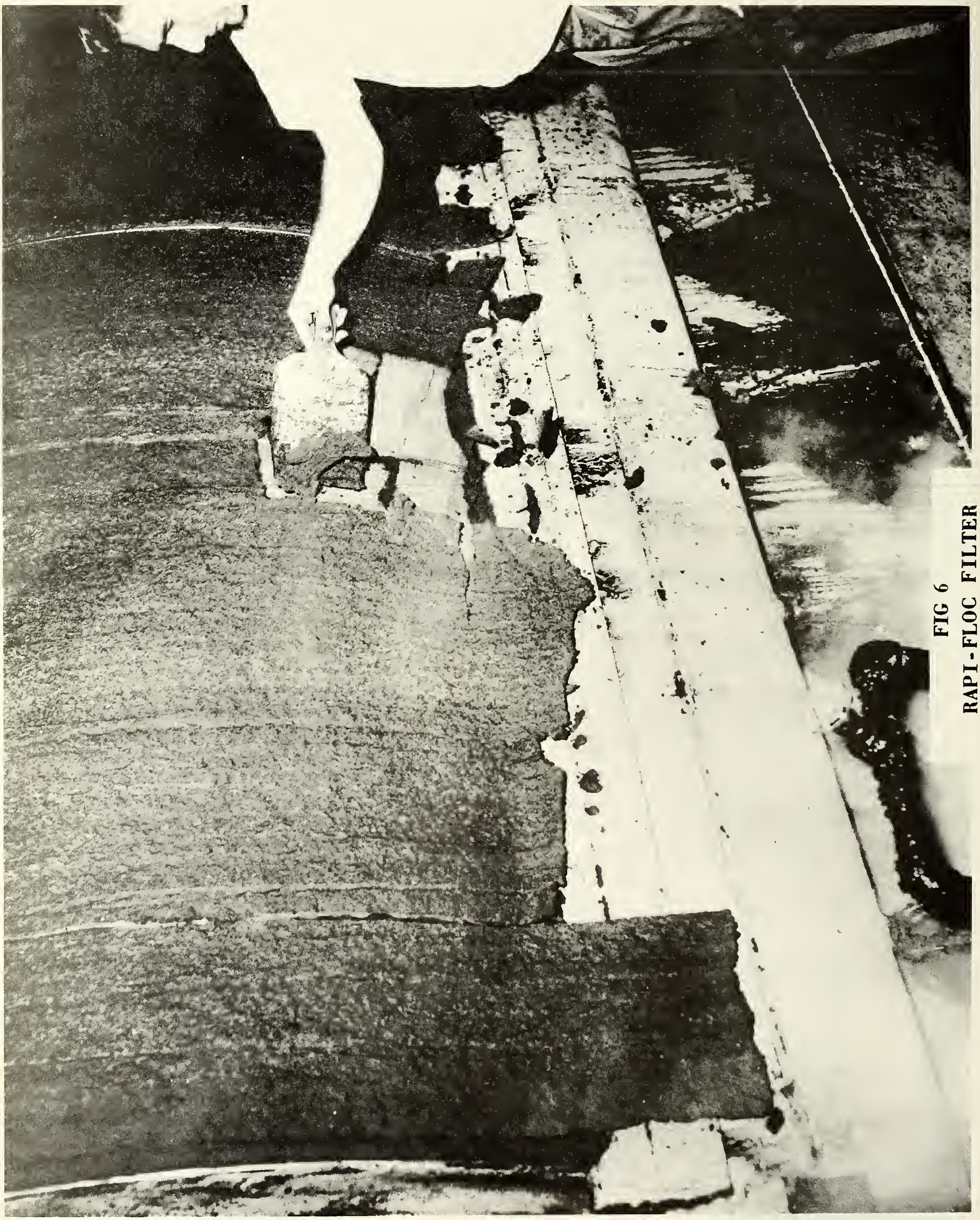


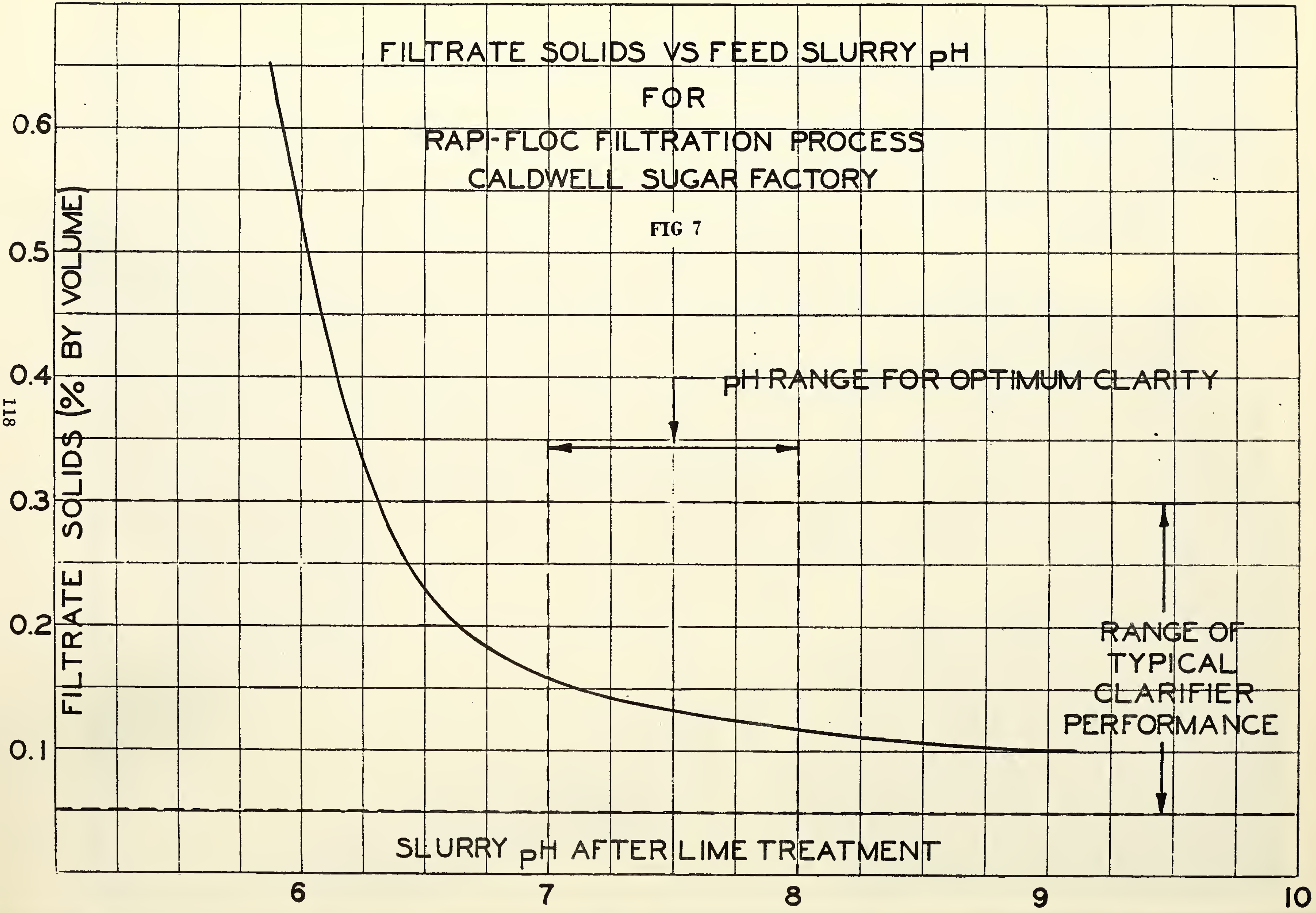
FIG 6
RAPI-FLOC FILTER
CALDWELL SUGAR CO-OP

TABLE II

SUMMARY

RAPI-FLOC FILTER PERFORMANCE DATA

FILTER		**FEED**	
Drum Speed	3-4 mpr	% Solids	12-25
Vacuum	15-18" Hg.	Temp.	160-170°F
Cover Wash Water	42 gpm	pH	6-6.3
Pressure	40-45 psi		
Temp. °F.	180-190°F		
Cake Wash Water	One set sprays		
FILTRATE		**FILTER CAKE**	
pH	6.9-8.1.	Thickness	3/8"-3/4"
Average	7.0-7.5	% Moisture	61-65
% Solids	.05-.32	Sucrose	3.0-5.0
Brix		Capacity	
1st Filtrate	8.5-11.3	Lbs/sq ft/hr	32-62
2nd "	4.0-7.2		
Purity			
1st Filtrate	70-75.8		
2nd "	70-76.0		



FILTRATE SOLIDS VS FEED SLURRY pH
FOR
RAPI-FLOC FILTRATION PROCESS
CALDWELL SUGAR FACTORY

FIG 7

TABLE III

CHEMICAL CONSUMPTION & COST

Chemical	Consumption Lbs/T.C.	Cost of Chemical/Lb	Chemical Cost Per Ton Cane
Lime	0.115	$ .0113	0.13 cents
AP-30	0.0108	1.20*	1.30 "
Total Chemical Cost			1.43 "

* Cost basis
2000 lbs or more

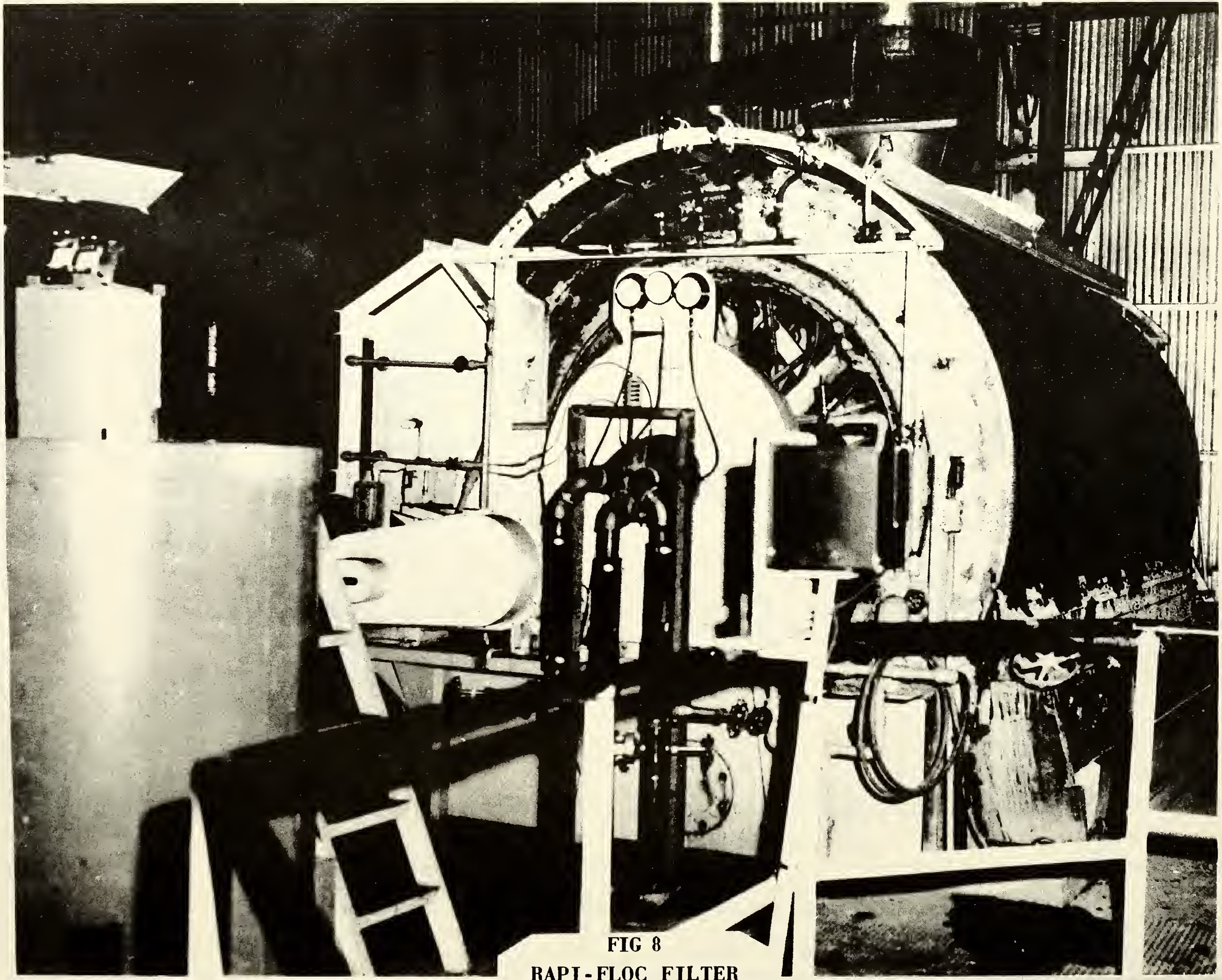


FIG 8

RAPI-FLOC FILTER

Separan AP-30[1] Used in Pilot Plant Experiments on Sugarcane Juice Clarification

by

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The American Sugarcane League compiled data on thirty-six Louisiana raw sugar factories for 1959, including information on the use of a flocculating agent, Separan AP-30, to improve clarifier operation. Of the twenty-eight factories reporting on the results of clarification with Separan; nine estimated improvement in clarifier capacity of 5 to 20 percent; one reported increased capacity only during adverse conditions of cane quality or harvesting weather; two had very slight or no improvement, and sixteen obtained questionable results. Since Separan has become widely used in sugarcane processing, with varying degrees of success, it was desirable to identify suitable or optimum processing conditions and to determine more accurately the effects of operating under such conditions. For these reasons, the League requested that a cooperative project be conducted involving a few pilot plant (1) tests on lime clarification of juice, with and without Separan, at the Audubon Sugar Factory of Louisiana State University during the 1960 harvest.

Moron and Keller (2) reported on laboratory studies during the 1957 crop at the Audubon Sugar Factory, followed by plant scale evaluation at the Iberia Sugar Factory, New Iberia, Louisiana, of a flocculating agent now designated as Separan AP-30. Separan was selected by Moron and Keller on a point basis in the laboratory as the most promising commercially available flocculating agent for sugarcane processing. The most effective treatment level and the place and method of addition to the system were determined, and the publication (2) of these observations resulted in its use by a large number of Louisiana factories.

---

[1] Separan AP-30 is a flocculant produced by the Dow Chemical Company; naming of this product and its selection for use in these experiments does not constitute the endorsement of this company's product over those of competitors that may be as suitable under the same experimental conditions. Chemically, it is a high molecular weight polymer of acrylamide containing approximately 30 percent carboxylic groups and 70 percent amide groups. The polymer, molecular weight between two and three million, is anionic in neutral and alkaline solutions and nonionic under acidic conditions.

[2] One of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

In planning pilot plant tests, USDA personnel visited eighteen factories prior to the 1960 crop to obtain detailed information on methods of Separan preparation and addition, dosage, liming conditions, clarifier and filter performance, and general information. Most of the factories followed the manufacturer's recommendations for use by continuous addition of 2 to 3 p.p.m. of Separan on cane to the clarifier flash tank from an 0.5 percent stock solution diluted 10 to 1 with a water stream as added. Juice was limed to maintain a reasonably constant clarified juice pH between 6.1 and 6.7. Several factories limed to the lower pH for low mud production while others preferred liming higher, depending on clarifier capacity and operational preferences. One limed to the higher pH while processing clean fresh cane and a lower pH during less favorable cane conditions to prevent overloading the clarification station. Comments on the value of Separan in sugarcane processing were numerous and sometimes contradictory.

Reports of factory personnel in general were, that if Separan improves operation at all, it is worth the few dollars per day that it costs each factory. A large percentage of the factories contacted used Separan continuously because it improved one or more of the following: clarifier capacity, juice clarity, mud consistency, mud quantity, mud filtration, cake sucrose, sugar product or overall operation. A smaller percentage used the flocculating agent only during periods of poor clarifier operation to lower the mud level, thicken the mud and "get out of the woods".

Pilot Plant Tests:

A second clarifier nearly identical to the first, was installed in the pilot plant clarification system at the Audubon Sugar Factory for the purpose of conducting experiments on modified or novel methods of clarification. By alternating clarifiers during processing of a given juice sample, it is possible to evaluate the effects of an additive in a standard lime clarification method as compared with the standard method without the additive. The processing rate of 50 gallons per hour duplicates factory conditions adequately to permit control of materials and conditions necessary for objective evaluation, without the variability of juice supply in a factory. Pilot plant work was planned with full control of both juice supply and operating conditions to supplement the laboratory and plant scale work reported by Moron and Keller.

Eight pairs of tests with Separan addition vs. standard lime clarification were made in the pilot plant during the crop. Sufficient cane was milled for each pair of tests to make two 4-hour runs. Data from the runs with standard lime clarification served also for two other test programs conducted during the season. Hand cleaned samples of cane from St. Gabriel provided material for comparisons of new varieties with the standard C.P. 44-101; other samples from commercial plantings were used in comparing the processing characteristics of cane harvested by the Cary combine with those of comparable cane mechanically harvested and burned by conventional methods. The extreme as well as average soil and trash contents of the samples represented a wide range of qualities which is desirable for the purpose of evaluating the coagulant (Separan) as a flocculant in clarification.

The addition of Separan was alternated between clarifiers, and between first and second runs of a given test, for uniformity of sequence in comparisons with the standard clarification. By shifting two plug cocks between the flash tank and the clarifiers, and shifting the mud discharge valve from one clarifier to the other, the second run of a test was started without changing any operating conditions except the starting or stopping of the Separan pump.

A stock Separan solution of 0.025 percent was added with a metering pump to the clarifier flash during one run of each test. Actual amounts added are shown in Table I, 1.8 to 2.2 p.p.m. on cane, and are in the range of 2.0 to 2.5 p.p.m. recommended by the manufacturer and used in several Louisiana factories. The low concentration, about one-half that for factory use, was to insure uniform addition and mixing at low flow rates, and should actually improve settling by dilution.

Test Results:

Operating data were averaged by variety, independently of the number of tests on each, for both the control and Separan runs to eliminate varietal processing characteristics in the comparisons. Operating data are compiled in Table I for Separan and juice, and in Table II for lime, mud and mud solids.

The rake froze on the new clarifier following run number seven and was inoperable during the next five tests. The mud solids (percent) and mud weights were estimated for these runs of each test by plotting values of actual insoluble mud solids per ton of cane vs. wet mud weights for all variety tests of the last three years. One exception is run number 15, with the estimated values obtained from the other seven Separan runs.

Separan had no effect on the amount of lime required for the desired clarified juice pH, on the pH drop across the juice heater and clarifier, or on the amount of insoluble solids in mud. There was no improvement in clarity except, possibly, in test number 10 when a lower pH was used. Filterability of clarified juice (3) was improved 25 percent, on average, and 84 percent for test number 10 with the lower pH. Insoluble solids, percent of mud, were improved 18 percent, on average, and 15 percent average for test numbers 7, 19 and 27 without corrections. Wet mud weight was improved 16 percent (less weight with Separan), on average, and 17 percent on tests 7, 19 and 27. The mud was thicker when using Separan.

Remarks:

Improvements in clarification obtained by the use of Separan are apparently independent of the harvesting method, and soil and trash content of cane, within the limits of these tests. The best improvement in filterability of clarified juice was obtained in test number 10, when processing juice of very high soil content, but at the lower pH.

By giving the mud percentage a weight twice that of the clarity percentage, a ratio is obtained for estimating clarification efficiency. For Separan, this ratio is (2 x 116 + 102) ÷ 3 = 111 percent as compared to the standard lime clarification of 100 percent.

Settling tests in 1000 ml. cylinders on limed juice from the clarifier flash tank averaged seven percent less mud volume with Separan than in the controls after two hours. Initial settling was very rapid with Separan, but with time, the difference in mud volumes decreased.

Standard lime-clarification processing tests on new varieties should include tests with Separan, since the clarification aid is being used in most Louisiana sugar factories. Additional nonstandard tests should be planned to determine the best pH for liming for the most efficient use of Separan.

ACKNOWLEDGMENT

We wish to thank members of the American Sugar Cane League, the Audubon Sugar Factory of Louisiana State University, and the numerous sugar factories in Louisiana who, together, furnished the information and assistance that made this work possible. We also thank members of Southdown Sugars, Inc., St. James Sugar Coop., Union Plantation and St. Gabriel Plantation for furnishing all sugarcane samples, without cost to the U.S.D.A., on schedule and harvested by the method specified.

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(2) Moron, M. M. and Keller, A. G. Sugar J., 22 (10), 27-31 (1959).

(3) Guilbeau, W. F., Coll, E. E., Fort, C. A., and Jackson, J. T. Sugar Bull., 39 (16), 186-191. (1961)

TABLE I: 1960 SUGARCANE PROCESSING EXPERIMENTS, SEPARAN AP 30 VS. CONTROL -- JUICE CHARACTERISTICS

Cane Variety	Run No.	Separan, ppm on Cane	Limed Juice pH	Clarified Juice			Dilute Juice Purity
				pH	Clarity[1]	Filter-ability[2]	
CONTROL:							
CP 44-101[3]	7	--	7.72	6.59	67	92	75.7
"	15-A	--	7.44	6.59	35	22	70.5
"	17-A	--	7.40	6.59	30	20	73.8
	Average	--	7.52	6.59	44	45	73.3
CP 52-68	19	--	7.40	6.61	21	12	79.3
CP 36-13[4]	27	--	7.42	6.61	38	39	73.8
N.Co.-310[4]	10-A	--	7.69	6.38	57	45	74.3
" [3]	11-A	--	7.66	6.57	50	63	70.5
" [3]	14	--	7.56	6.61	50	36	77.4
	Average	--	7.64	6.52	52	48	74.1
	Variety Average	--	7.50	6.58	39	36	75.1
SEPARAN AP-30							
CP 44-101[3]	7-A	2.2	7.74	6.65	67	96	76.3
"	15	1.8	7.51	6.65	36	30	71.4
"	17	2.2	7.39	6.60	28	25	74.7
	Average	2.1	7.55	6.63	44	50	74.1
CP 52-68	19-A	2.1	7.35	6.57	21	14	79.2
CP 36-13[4]	27-A	1.9	7.42	6.58	40	48	72.6
N.Co.-310[4]	10	2.0	7.69	6.37	62	83	74.7
" [3]	11	1.9	7.65	6.59	49	80	71.3
" [3]	14-A	2.1	7.52	6.62	47	43	77.4
	Average	2.0	7.62	6.53	53	69	74.5
	Variety Average	2.0	7.49	6.58	40	45	75.1

[1] Adjusted to 14° Brix (Luximeter reading)

[2] Milliliters through 47 mm. diam., 1.20 µ Millipore filter in 10 minutes at 25 inches vacuum and 33° C. Temp.

[3] Cary harvested Commercial Canes

[4] Conventional harvested and burned Commercial Canes

TABLE II: 1960 SUGARCANE PROCESSING EXPERIMENTS, SEPARAN AP 30 VS. CONTROL --

MUD CHARACTERISTICS

Cane Variety	Run Number	Lime Used, Lbs./Cane	Insoluble Solids, % of Mud	Wet Mud	Insoluble Solids Actual	Insoluble Solids Adjusted[1]	Mineral to Organic Ratio
					Pounds per ton cane		
CONTROL:							
CP 44-101[2]	7	1.81	7.4	165	12.2	8.8	1.25
"	15-A	1.78	6.0	161	9.6	8.6	0.61
"	17-A	1.96	6.7[4]	162[4]	10.8	9.3	0.69
	Average	1.85	6.7	163	10.9	8.9	0.85
CP 52-68	19	1.64	7.5	160	12.0	10.0	0.59
CP 36-13[3]	27	1.07	19.7	154	30.4	8.2	3.72
NCO-310[3]	10-A	1.24	22.0[4]	188[4]	41.3	9.1	5.21
" [2]	11-A	1.68	7.2[4]	137[4]	9.9	7.2	0.88
"	14	1.29	7.0[4]	131[4]	9.2	7.6	0.78
	Average	1.40	12.1	152	20.1	8.0	2.29
	Variety Average	1.49	11.5	157	18.4	8.8	1.86
SEPARAN AP-30							
CP 44-101[2]	7-A	1.83	9.2	126	11.6	8.3	1.23
"	15	1.75	7.3[4]	130[4]	9.5	8.4	0.64
"	17	1.87	7.7	141	10.9	9.2	0.69
	Average	1.82	8.1	132	10.7	8.6	0.85
CP 52-68	19-A	1.72	7.7	156	12.0	10.1	0 64
CP 36-13[3]	27-A	1.03	22.7	129	29.3	8.1	3.55
NCO-310[3]	10	1.22	28.6	155	44.3	12.5	5.41
" [2]	11	1.67	9.5	117	11.1	8.4	1.13
" [2]	14-A	1.34	9.7	93	9.1	7.5	0.87
	Average	1.41	15.9	122	21.5	9.5	2.47
	Variety Average	1.50	13.6	135	18.4	9.1	1.88

[1] To 1.0 lb. field soil per ton cane in dilute juice.

[2] Cary harvested commercial canes.

[3] Conventional harvested and burned commercial canes

[4] Estimated from total insoluble solids, clarifier rake not operated

DEVELOPMENT OF THE RUBBER-BELT INTERMEDIATE CARRIER

By

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The first intermediate carrier was required as soon as two mills were put together to form a tandem. Our records show that the first Farrel Tandem was a nine-roll mill shipped in 1889. The earliest type of carrier was similar to the cane conductor, consisting of chains and wooden or steel slats forming an apron. This general design has persisted in the Caribbean area until the present time.

In other parts of the world the Meinecke and the Ewart types have found widespread use.

The Meinecke type, which consists of a totally enclosed upward inclined chute and an open discharge chute inclined downward into the roll bite of the following mill, is the poorest of all types so far as feeding is concerned. It does have the advantage of having no moving parts, hence very little maintenance is required. Scrapers must be accurately made and adjusted. Maceration cannot be conveniently applied. Modified types with force-feed rolls at the entrance to the following mill have been proposed.

The Ewart type, which is in limited use today, consists of transverse angle irons supported by chains being dragged along the bottom of an horizontal steel plate tray. This still results in uneven feed, although, if the proper speed is selected, it is a considerable improvement over the Meinecke. It does have the disadvantage of wear because of moving parts, and is quite an obstacle to the clearing of a mill choke.

The apron-type carrier continued to predominate in the Caribbean area with gradual improvement. Here, of course, the whole bottom of the carrier was "live" and the number of moving parts much greater than in the other types. In fact, everything except the side plates was in motion and, therefore, subject to wear. This design, however, had many things in its favor. It was "open" so that the mill operator could observe the bagasse blanket at all times; maceration was easy to apply and free access was provided in the event of a mill choke. The main advantages, though, were the uniform flow of the blanket from mill to mill and the improved feeding action at the roll bite.

The big step forward in intermediate carriers came with the introduction of the rubber-belt type. As long ago as 1926 the late Philip V. Tippet realized the disadvantages of the various types of carriers then in use. With the passage of time the steel slat apron-type had become the favored design because it performed the best; but it also required the most maintenance, frequently requiring nearly 100% replacement the third season.

Early in 1951 Mr. Tippet felt that he had a workable idea for a belt-type and he started searching for a belt source. This was not an easy task. Seven belt manufacturers turned him down for various reasons, mostly because of a lack of suitable manufacturing equipment. Finally he found one company, The B. F. Goodrich Company, which was in a position to offer a belt of a design which could be adapted or modified to the requirements thought necessary for carrier service. After much negotiation, a mold design was worked out which provided the patented centering cog-type of vee-shaped lug on the underside of the belt and Tippet's design of cleat on the carrying surface.

In 1952 the first unit-type of rubber-belt intermediate carrier was manufactured and made interchangeable with an existing steel slat apron, unit-type carrier at Central Plata in Puerto Rico. This carrier was for a 34" x 66" tandem and was installed between the 5th and 6th mills during a 3-hour shut-down of the tandem on February 22, 1953.

The original belt and carrier were continued in use through six crops, carrying approximately 2 1/2 million tons of cane without, to quote the chief engineer, Mr. Rafael Labiosa, "a single minute lost time due to mechanical failure of the rubber belt or the rest of the components of its units."

The rubber covering on this first belt, however, was only 1/16" thick on the working surface or carrying side and 1/32" on the underside. Neither of these layers was found to be adequate as there was, of course, some wear, and subsequent belts have had 1/8" of rubber applied over all fabric areas.

After six crops the original belt was replaced but is still held at Plata as a spare. The Mill Management at Plata expects considerably longer life from the replacement belts. Our expectation is approximately ten crops.

From reports and our own observations, we are pleased to be able to say that the satisfactory and trouble-free service record of the Plata belt will not only be matched but undoubtedly exceeded in many of the installations which have followed.

The great advantage of the belt over the steel slat apron, and indeed, the reason for its conception, is the tremendous saving in maintenance. This reason alone justifies the use of this type of carrier. Additional advantages are the elimination of bagasse droppage into the juice pan and the retention of maceration water in the bagasse blanket. Perhaps the most important extra bonus of all is the force-feeding action available with the rubber belt. When properly positioned and with the belt speed properly coordinated with the mill-roll speed, it is possible to obtain considerable force-feeding action.

Some users of the belt carrier have found that previous attempts to use a force-feed roller have resulted in slat damage to their slat-type aprons. This does not occur with the rubber belt because it is supported under its full width by the driving drum. The full-width drum also assures positive drive with a minimum of belt tension. A sag of 3" to 6" between drums, depending on carrier length, is satisfactory.

Up to the present time we have furnished over 60 rubber-belt carriers. The belt size has ranged from 36" width by 14' length to 84" width by 38' length. Most have been in the larger sizes. A number of these have been chassis for conversion of existing carriers where the customers have wished to obtain the economies of using existing transmission equipment, as well as carrier sideplates, burro or cheek plates, scrapers and feed rolls.

The belt material externally resembles tire-tread stock. It is of 3-ply construction with 1/8" rubber top and bottom and has a total thickness of approximately 7/16". The carrying lugs on the top surface of the belt are of trapezoidal cross-section approximately 5/8" high and spaced 6" apart. They extend across the width of the belt at right angles to the direction of travel.

The off-season care of the belts is the same as for most rubber goods - store in a dark, dry and cool location. In most sugar growing areas it is hot and humid and the sunshine is brilliant and, as a result, we find that the recommended care is seldom followed. In case of damage to the belt there are two main types of repair kits. One is the liquid type to seal any exposed fabric so that it will not shrink from moisture and warp the belt. The other type is a metal fastener for repairing massive damage, such as may occur from tramp iron.

THE PERFORMANCE OF INDIVIDUAL GRINDING UNITS OF SOME TANDEMS

By

LOUIS CUSACHS

The routine factory and laboratory tests do not include those of the extractions of the separate grinding units in the milling train or tandem. Under such conditions it is not known how well, or otherwise, each grinding unit contributes to the overall performance of the tandem.

A few factories in the tropics make occasional tests of individual grinding units. The results disclose the comparatively poorer performance at times, of one unit and occasionally of more than one unit in the milling train. As will appear later this is true of the results which are reported here.

The specific method of which these results were obtained has been described to this Society. This method is based on soluble solids rather than on polarization. The overall results are usually 2% less than those which appear in the factory reports and which are based on polarization.

The tests were made on each tandem as the tandem was being operated on that particular day. The results are classified according to the number of grinding units in the different tandems. Except in one case in which only one tandem of a certain number of grinding units was tested on one occasion only, the other values are averages of several tests and predominately of different tandems with the same number of grinding units. The data on some domestic tandems are plotted in Figure 1. The tandems with four, five, six and seven grinding units are designated I, II, III, and IV, respectively.

The curves show the progressive cumulative extractions by the individual grinding units. The hydraulic loading in tons per linear foot of the top roll of each grinding unit has been entered as a symbol in line with both the numerical value of the loading and the numerical order of the grinding unit in the tandem. The individual and overall extractions shown by the curves are: -

I. 52.9; 19.3; 8.7; 6.3 — 87.2
II. 45.7; 16.2; 13.2; 6.5; 6.1 — 87.7
III. 34.1; 27.9; 9.1; 8.1; 4.5; 4.3 — 88.0
IV. 31.4; 29.6; 8.7; 6.5; 5.8; 3.5; 3.9 — 89.4

The extractions by the first grinding units decrease as the number of grinding units in the tandems increase.

Corresponding data on some tandems in the tropics have been plotted in Figure 2.

A. 66.1; 13.0; 9.9; 4.7 — 93.7
B. 31.7; 27.8; 16.8; 8.9; 5.4 — 90.6
C. 24.2; 34.3; 17.2; 6.8; 5.8; 3.2 — 91.5
D. 20.1; 13.7; 32.4; 11.6; 5.7; 6.1; 3.2 — 92.8
E. 39.5; 17.1; 13.0; 10.8; 6.1; 4.3; 2.9 — 93.7
F. 21.0; 15.1; 15.3; 14.8; 10.3; 7.1; 5.5;3.7 — 92.8

Curve A is for the only tandem with four grinding units on which tests were made in a particular tropical country. The curves show a decrease in the extraction by the first grinding units from A to the lowest, D, whereas the value in curve E is greater than in B. The tandems which are represented by D and F, have multiple crushers (two and three, respectively). The results for D and F may be responsible for the disfavor in which such installations are held by some mill engineers. The writer does not subscribe entirely to this belief.

Two conditions have been observed as contributing factors to the initial extractions, which are also true for the performance of subsequent grinding units in a milling train, but which have a more pronounced influence on the first grinding unit.

1. The feed of cane.

2. The preparation of the cane which is being fed.

In some cases 1 and 2 are interrelated. Two other indications are also applicable: The regularity of the lift of the top roll and response of the lift to different applied hydraulic pressures.

1. In a number of instances the improvement in the preparation of the cane had led to difficulties in the feed to the first grinding unit. The most obvious solution was to increase the opening of separation of the rolls of the first grinding unit. As a result the second grinding unit choked when there was any appreciable lift of the top roll of the first grinding unit. This in turn was corrected by the application of such hydraulic pressure to the top roll of the first grinding unit that the latter could not lift with cane passing between the rolls. This procedure is effective in regulating the feed to the following mills in the tandem but the performance of the first grinding unit is impaired.

Feed chutes to the crushers have been found to be at fault in many cases. When satisfactory height and slope can be provided these chutes offer no difficulty. In Louisiana and elsewhere "star feeders" have been installed in the existing chutes in front of the crusher whereby the "hold-up" of the prepared cane to the crusher is prevented, when the "feeder" is designed and and installed properly. It has been possible to increase the hydraulic pressures on the top rolls of the crushers in some cases after the "star feeder" were installed.

2. The better cane is prepared, the more readily is the juice with its components amendable to extraction. The "hold-up" of well prepared cane in the chutes is an indication of the larger co-efficient of friction of this material against the metal surface of the chutes. This in turn

increases the gripping by the mill rolls. An illustration is afforded by the reaction of a first grinding unit, when the hydraulic loading on the top roll was increased progressively, the engine stalled and stopped before the rolls of the grinding unit showed any sign of slipping or choking. The procedure was repeated with the same results when the same value of applied hydraulic pressure was reached.

The highest values of the extraction by the first grinding unit, curves I and A, were from well prepared cane. In the case of three-roll mills as first grinding units, hydraulic loading up to 67 tons per linear foot of roll has been applied to the top roll.

The preparation of cane and bagasse is of the utmost importance in analytical work, if one wants to compare the results. Once in a while this fact is rediscovered by those who had not read the publication of the original work on the effect of particle size in the recovery of juice with its components from sugarcane. Much credit is due to L. R. Bliss, not only for his studies, but for those which were inspired by his publications. Bliss found that bagasse which polarized 3.61%, when screened and the pieces classified according to particle size, gave the following results in order of increasing particle size:- 2.11%, 2.10%, 2.90%, 3.29%, and 4.14%. The polarizations are the resulting averages of five determinations on each sample.

The performance of the other grinding units after the first can be judged by the slopes of the curves which precede the points which designate the order of the grinding units in each curve. As many mill engineers have observed: the objective is approached always, but sometimes in a round-about manner. The mill which follows a weak unit, i.e., one with low extraction, is frequently a strong unit: the second grinding units in curves III and IV in Figure 1, and the same units B and C in Figure 2. Curve

D in the latter shows a strong third unit which is preceded by two weak units.

The curves in Figure 1 show only one intersection, at units 2 of curves II and III. Otherwise the cumulative extractions are lower for the corresponding units for the tandems with more units. There are more intersections of curves in Figure 2, which include one of D and F between points 2 and 3, but the pattern is similar.

The corresponding lower performance of the first four or more units in the longer train of mills than of the similar units in the shorter train of mills, might suggest that the engineers in charge of the former attach less importance to the earlier mills in the tandem. It can also be a reflection on the knowledge which is still needed to establish the settings of the mill rolls when many units are involved. A qualification is also in order, that some of the longest train of mills were operating at reduced grinding rates when the tests were made.

It has happened sometimes that a mill which had been considered to be inferior to another was actually performing better in the sense of extraction than the one which had been considered to be better. Mill or unit 2 of A was operating with a split top brass, which was boxed with angle iron, at the time the test was made. Every time the teeth of the crown gears engaged there was a separation of the top brass. The hydraulic loading on the top roll had been reduced to prevent further damage. It should be noted that notwithstanding this condition the performance of the tandem was very good.

The hydraulic loading on the top roll of each grinding unit has been included in Figures 1 and 2. As in the case of other mill data correlations are not always possible. Too frequently scatter diagrams are obtained instead of points through which smooth curves can be drawn. This suggests that the usual methods of control are not sufficiently good, or are not sufficiently well applied to render results which are sufficiently reproducible.

Quite a bit of information is obtained from graphs of the cumulative extraction according the individual grinding units. The following data are presented from two tests made on the same tandem which some adjustments were made on the mills:

1a.	25.8	24.5	18.4	9.5	3.4	6.1	Total	extraction	87.7
1b.	35.5	26.6	13.2	8.9	4.1	2.4	"	"	90.7

The extraction by the first, second and fifth grinding units have been improved while the other grinding units show lower extraction values in the second test. By dividing the extraction of each grinding unit by the soluble solids which entered that unit, the following is obtained:

1a.	25.8	33.0	37.0	30.4	15.6	33.3
1b.	35.5	41.2	34.8	36.0	26.0	20.1

Assigning the term "efficiency" to these values, the third grinding unit in 1a., has the highest efficiency, followed by 6 (grinding units) 2, 4, 1, and 5. In 1b. the order 2, 4, 1, 3, 5, and 6. It is generally agreed that the values should be in decreasing order from the first grinding unit to the last. An idea of the extent of required correction should preferably be based on the efficiencies. It should be recognized also that the correction of a front mill usually requires adjustments in the following mill, and sometimes following mills.

Figure 3 shows the results of a test in which bagasse samples were taken from the last mill of a tandem to correspond to four different speeds of the mill drive engine. The other conditions were that the cane was being delivered from the same field, the feed to the tandem was maintained the same, as closely as it was possible, and the mill engines drive of the other mills were kept constant during the test.

Determinations were made of moisture, soluble solids, and fiber in shredded portions of the bagasse samples. Curve I depicts the change in moisture of the bagasse at different r.p.m. of the engine. Curve II shows the corresponding changes in soluble solids. Curve III shows the soluble on the basis of bagasse with the same fiber content. The four speeds of the mill engine, 52, 57, 60, and 64 r.p.m., correspond respectively to 46.1 ; 50.5 ; 53.2 ; and 56.7 ft. per min. of speed for the mill rolls. The length and diameter of the mill rolls were comparatively small. Above 53 ft./min. roll speed the loss of soluble solids in the bagasse increases rapidly. Such data can be of practical use at times when the mill rolls become smooth and some remedy must be found to maintain satisfactory grinding rates.

As on many phases of milling, mill roll speeds are considered from widely diverging, if not opposite, points of view. There are adherents to high crusher roll speeds, which results in thinner mats of cane and easier feeding of the crusher in regards to the gripping of the cane, but which can make uniform feeding difficult. It seems that there is an optimum thickness of mat for the opening between the rolls of the crusher, of an optimum compression ratio under prevailing rate of feed and roll speed. Thinner and thicker mats could result in less extraction. Comparatively low crusher roll speeds permit uniform feed, and as more time is allowed for drainage from the cane mat, from the material with the largest amount of juice, it does not appear that the performance of the crusher need to suffer if other suitable conditions are maintained.

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Figure 1

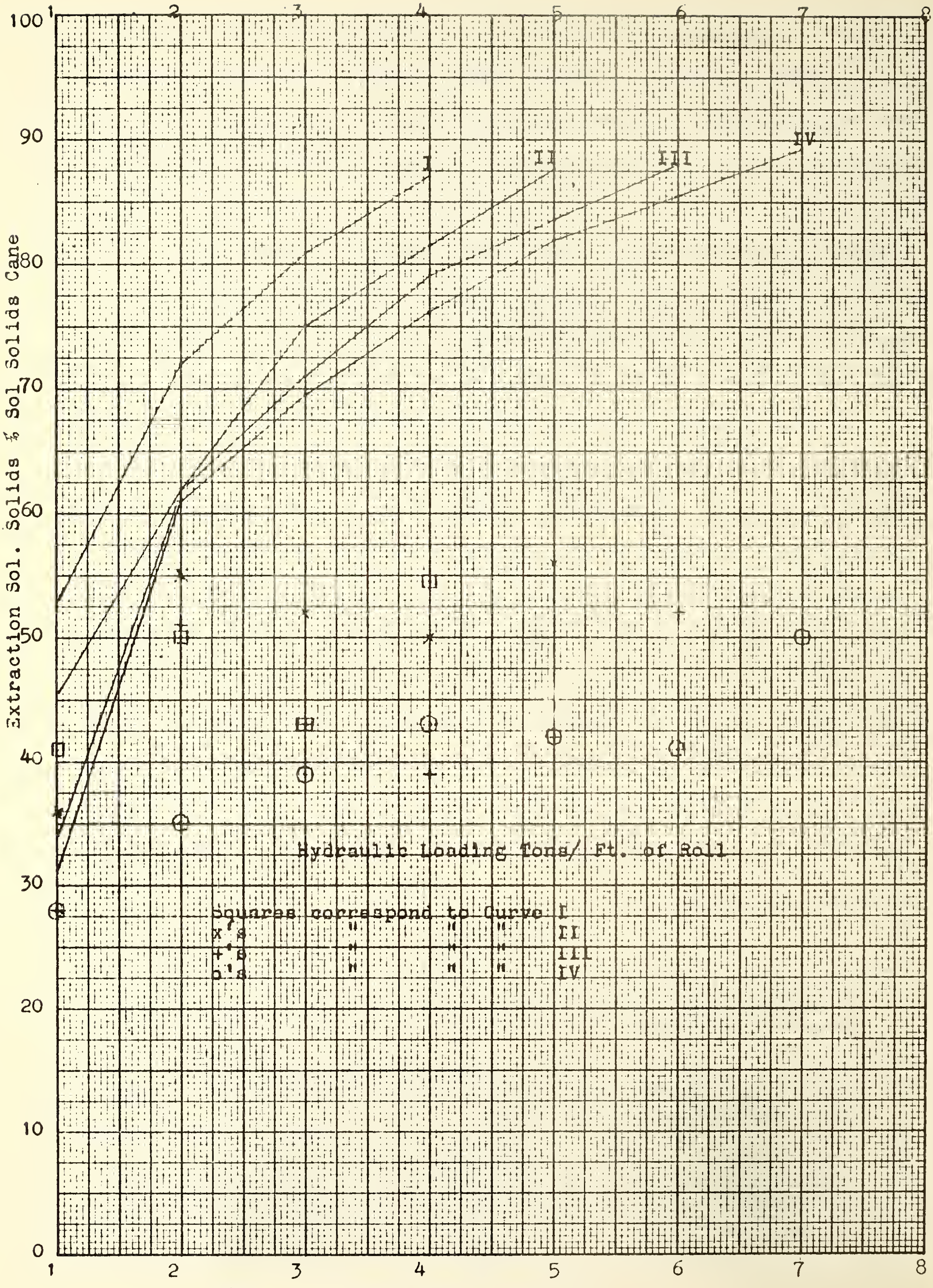

Extraction Sol. Solids % Sol Solids Cane
0
10
20
30
40
50
60
70
80
90
100
Grinding Unit in Tandem
1
2
3
4
5
6
7
8
Hydraulic Loading Tons/ Ft. of Roll
1
2
3
4
5
6
7
8
I
II
III
IV
Squares correspond to Curve I
x's " " " II
+'s " " " III
o's " " " IV

Figure 2

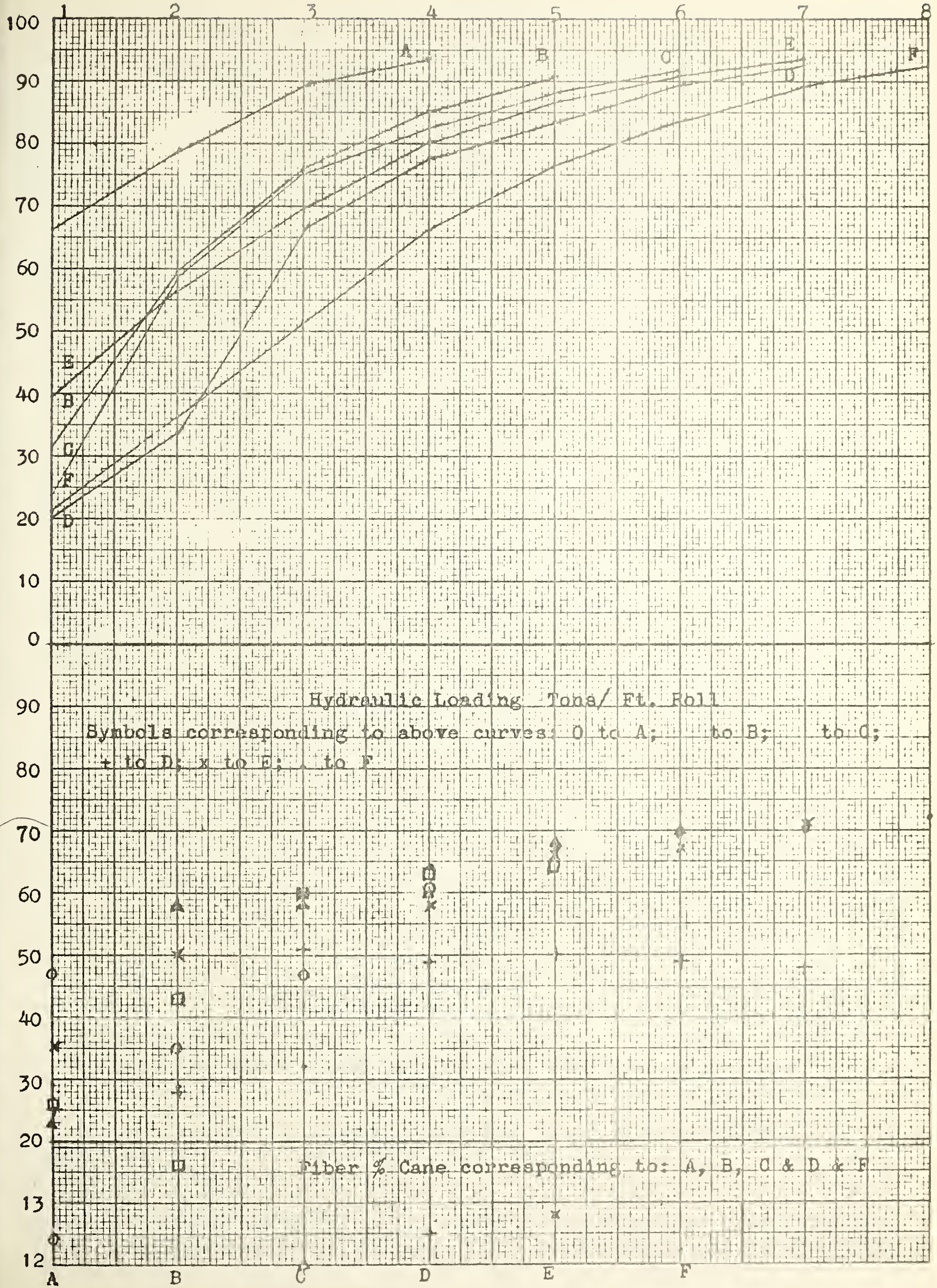
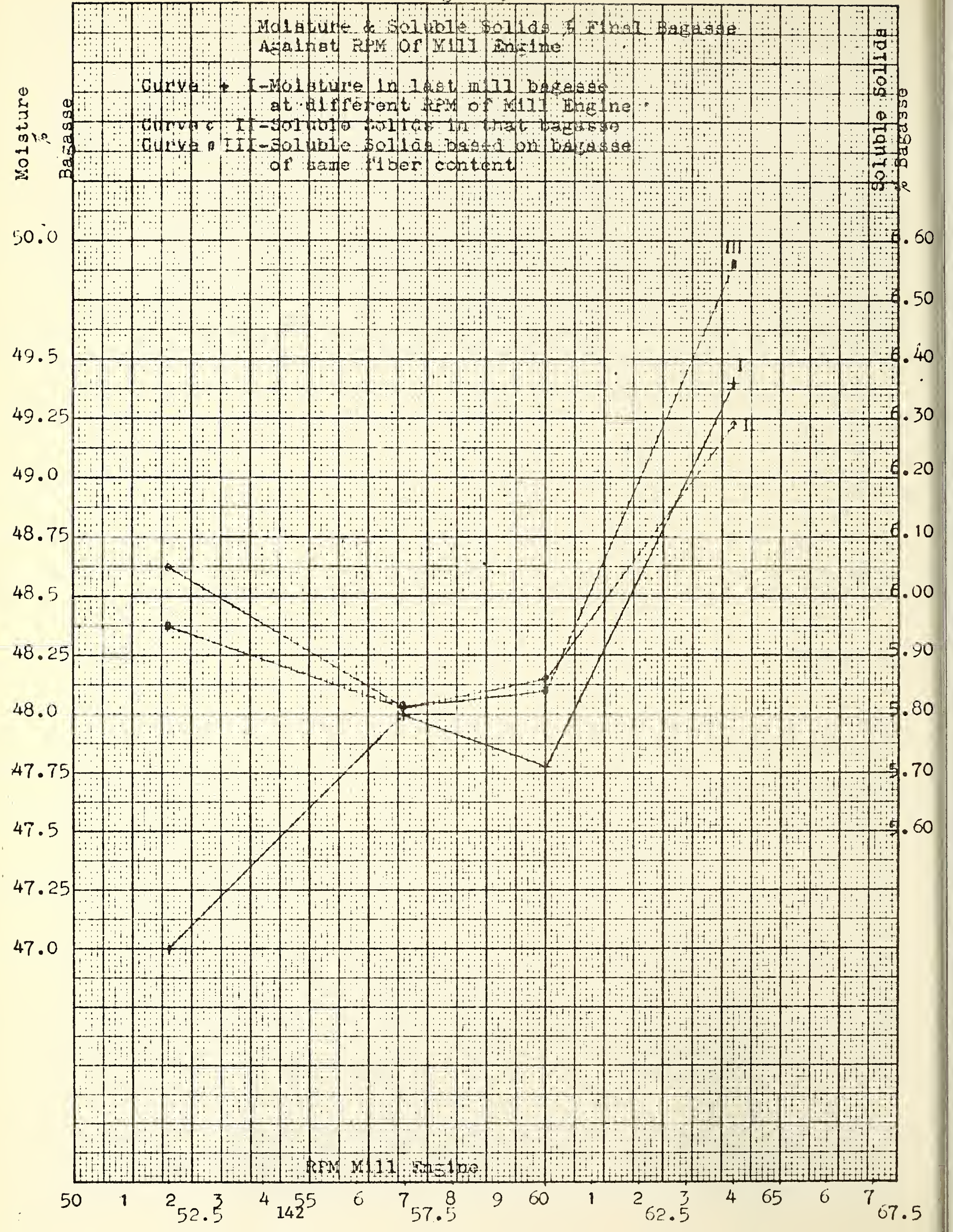

1
2
3
4
5
6
7
8
100
90
80
70
60
50
40
30
20
10
0
A
B
C
D
E
F
E
B
C
F
D
90
80
70
60
50
40
30
20
13
12
Hydraulic Loading Tons/ Ft. Roll
Symbols corresponding to above curves: O to A; to B; to C;
+ to D; x to E; to F
Fiber % Cane corresponding to: A, B, C & D & F
A
B
C
D
E
F

Figure 3


Moisture & Soluble Solids % Final Bagasse
Against RPM Of Mill Engine
Curve + I-Moisture in last mill bagasse at different RPM of Mill Engine
Curve ¢ II-Soluble Solids in that bagasse
Curve ∎ III-Soluble Solids based on bagasse of same fiber content
Moisture % Bagasse
Soluble Solids % Bagasse
50.0
49.5
49.25
49.0
48.75
48.5
48.25
48.0
47.75
47.5
47.25
47.0
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
III
I
II
RPM Mill Engine
50
1
2
52.5
3
4
55
142
6
7
57.5
8
9
60
1
2
62.5
3
4
65
6
7
67.5

SUGAR MILL KNIFE LIFE

By

Mr. Victor J. Bailliet, Caldwell Sugar Cooperative
Mr. Frank Vought, Westfield Factory
Mr. Luis Suarez, Glenwood Factory

This paper will be discussion and exhibit by Mr. Bailliet, Mr. Vought, and Mr. Suarez on knives. We hope that the display, showing a model knife of each factory before and after the grinding season, along with a brief discussion from each gentleman will be helpful to us all.

The following includes some data on the knife set of each factory:

Caldwell Sugars - Mr. Bailliet

"The advent of the mechanical harvesting which brought more foreign matters with the cane and the trend to increase the grinding rate of the mills resulted in problems with the cane knives efficiency and life.

In Louisiana, the cane knives are generally cut from steel plate or flat bars and the cutting edge is either made by forging or by cutting a level with a torch.

On the straight side, a layer of hard metal is deposited by fusion. This method allows the wear to be much greater on the leveled side, thus maintaining a relatively sharp edge. The efficiency of this practice depends largely on the hard facing material used and to a certain extent, the thickness of the layer. The most commonly made hard facing deposit is composed of extremely hard granules of tungsten carbide embedded in a thin fused layer of steel. The weakness of this system lies in the fact that when the conding steel wears, the hard granules are pulled out and the knife edge becomes dull and round.

At Caldwell, we tried different homogenous hard facing materials and found that a cobalt base alloy was best for that use. We cut our knives in a 5/8" thick mild steel plate and bevel the cutting edge (one side) with a torch; the hard alloy is deposited with a welding torch on the straight side to form a layer of about 2" width at the end and 1/16" thick.

Our set of knives revolving at 500 RPM have the knife tips set originally at 3/4" from the carrier slats. During this last grinding season, the first set lasted 34 days for a grinding of 104,000 tons of cane, and the second, the full crop: 45 days and 141,600 tons of cane.

The total wear amounted to about 1½" but the knives remained sharp, which allowed an efficient cane preparation with our limited power supply"

Caldwell Sugars Co-op., Inc. Sugar Mill Knife Information

Characteristic of each set	1st set	2nd set
Horse Power per Unit	350	250
Number of Blades	24	30
Distance from Carrier	1"	3/4"
RPM of Knife Shaft	500	500
Knife Circle tip to tip	64"	58"
Tons of Cane Ground per knife Change	104,000	141,600
Amount of Wear during this time	2"	2"
Pounds of Hard Surface on each knife	.4 lb.	.4 Lb.
Hard Surface on one side or both	one side	one side
Type of Steel used for Base Metal	Varchrom	Mild Steel
Is Cane Washed	yes	yes

Westfield Sugar Factory Mr. Vought

Characteristics of each set	1st set	2nd set
Horse Power of Unit	313	313
Number of Blades	28	28
Distance of Carrier	14"	3/4"
RPM of Knife Shaft	502	502
Knife Circle tip to tip	60"	67"
Tons of Cane Ground per knife change	176,000	109,000
Amount of wear during this time	1.75"	1.125"
Pounds of Hard Surface on Each Knife	0.4	0.4
Hard Surface on one or both sides	(one side)	(one side)
Type of Steel used for base metal	Jalloy	Jalloy
Is Cane Washed	yes	yes

Glenwood Sugar Factory Mr. Suarez

	One set
Horse Power of Unit	530
Number of Blades per set	72
Distance from carrier	3/4"
RPM of Knife Shaft	510
Knife Circle, tip to tip	57"
Tons of Cane ground per set of knife changes	175,000
Amount of Wear	
Pounds of Hard Surface on each knife	1
Hard Surface on one or both sides	Both
Is Cane Washed	yes

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PROCEEDINGS

American Society of Sugar Cane Technologists

Volume 9 – Papers for 1962

February, 1963

PROCEEDINGS

American Society of Sugar Cane Technologists

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FOREWORD

This is the ninth volume of proceedings of the Society which have been published since its founding in 1938.

The first volume published in 1941 included papers presented during 1938, 1939 and 1940. Mr. Walter Godchaux, Jr., the then Secretary-Treasurer, edited that edition.

The second volume published in 1946 included papers presented during 1941-1945 inclusive. Dr. E. V. Abbott, Secretary-Treasurer, edited that edition.

The third volume published in 1953 included papers presented during 1946-1950 inclusive. A fourth volume was published in 1955 and presented papers for the years of 1950 through 1953. Volume five contains papers for the years of 1954 and 1955. The sixth volume included papers presented during 1956. The third through sixth volumes were edited by Dr. Arthur G. Keller.

This ninth volume includes papers for the year 1962 and has been compiled by the writer.

Denver T. Loupe

Secretary-Treasurer

February, 1963

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OPERATIONS OF THE DIVISION OF AGRICULTURAL CHEMISTRY

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Division of Agricultural Chemistry
Box 589, Baton Rouge 1, Louisiana

LOUISIANA STATE UNIVERSITY LIBRARY

The farmer is often at a disadvantage because he must buy and sell on the other parties' terms. As the farmer began to use feeds, fertilizers, and pesticides, items that had to be purchased from others, it became apparent that protection was needed. Some means of assuring the farmer that he got what he paid for had to be found. The Louisiana feed, fertilizer and pesticide laws were enacted for this purpose. There is strong evidence that sugar planters were moving forces in this cause. Louisiana was one of the first states to provide consumer protection of this kind. The fertilizer law was enacted in 1886, the feed law in 1904, and the pesticide law in 1890. With the passage of time these laws have been revised but the basic intent remains: feeds, fertilizers and pesticides must be labeled to show their content and they must meet label claims. As this is one of the oldest functions of your Department of Agriculture, it may be sometimes overshadowed by more recent developments. It may be worthwhile to review here the operation of these laws.

The Commissioner of Agriculture and Immigration is responsible for enforcement of the laws. The Director of Louisiana Agricultural Experiment Station is designated as the State Chemist with responsibility for analyzing samples submitted by the Commissioner's inspectors. The overall enforcement program is a joint effort with the two agencies working closely together to provide protection for the farmer. The Division of Agricultural Chemistry has been assigned the specific function of enforcing these laws.

Before any feed, fertilizer or pesticide can be sold in Louisiana it must be registered with the Commissioner. In most cases, registration is granted but applications are carefully examined and products which are not effective for the purpose claimed are denied registration.

Eight inspectors are assigned to specific districts in the state. These men check for registration and proper labeling and take samples of the products offered for sale. The samples are sent to L.S.U. for analysis. When completed the analyses are reported to the purchaser and the manufacturer. If the analysis meets or exceeds legal requirements no figures are shown on the report. If there is a deficiency the actual analysis is shown on the report. There has been some discussion as to the matter of tolerances on these reports. Tolerances for feeds and fertilizers are established by law. Because of the complex nature of pesticides and the constant addition of new materials it is not feasible to write tolerances for them into the law. Tolerances for pesticides are established as an administrative procedure based upon past experience. Studies in Louisiana, as well as in other states, have shown that there are certain unavoidable variations in sampling and analysis that must be taken into account in law enforcement. Very seldom will two chemists obtain the same results from analysis of the same sample. If, for example, a sample of 2% endrin granules was analyzed, the results might show 1.9% endrin. A second sample from the same lot might show 2.1% endrin. It would not be fair to accuse a manufacturer of misrepresentation under these circumstances. Slight deviations within practically established limits of analytical precision are not considered evidence of wrong doing. Tolerances are for the laboratory, not the manufacturer.

When deficiencies are found a number of possible courses of action are available. For feeds and fertilizers definite penalty scales are established by law. Approximately $7,000.00 in penalties were assessed and collected in 1960-1961. Sometimes it is possible to stop sale of off-quality products. In other cases the seller is requested to make replacement with good material or to make adjustment with the purchaser. Less often, applied remedies are court action and cancellation of registration.

The enforcement of these laws is financed by a twenty-five cent per ton inspection fee on feeds and fertilizers and a ten dollar per brand annual registration fee for pesticides.

Because of seasonal demands the facilities of the laboratory are not always used to full capacity for official work so considerable time is given to service work. Analytical work is done in connection with research projects of other departments of the Experiment Station. For example, we are currently analyzing feeds and forage for a beef production study at Jeanerette. The services of the laboratory are also available to any resident of Louisiana so long as the sample is concerned with agriculture. If any of you wish analysis of hay, silage, lime, water, etc. just send the sample to the laboratory with an explanation of the kind of analysis you wish.

When samples are for information only, the individual may send them in himself. However, such samples have little legal status. If you have a problem with feed, fertilizer, insecticide, pesticide, etc. contact your district inspector if you know him or nitify the Baton Rouge office. An inspector will take the necessary samples as promptly as possible and if necessary a "rush" analysis can be arranged for. There is, of course, no charge for any work of this kind.

In addition to the feed, fertilizer and pesticide work, this Division enforces the Dangerous Herbicide Law and represents the Commissioner on the Stream Control Commission.

In closing, Louisiana has adequate laws for protecting the consumer of feeds, fertilizers, and pesticides. An alert inspection force and excellent laboratory facilities are actively employed for enforcement of the laws. But one must look out for himself. No law can protect a careless man. Two ways in which one can help himself are: First, deal only with reputable suppliers. When one buys on price alone he is looking for trouble. Second, read the label and be sure it is understood. A very great amount of effort is expended by state, federal, and industrial agencies to see that informative labels are used. Know what you are buying. Don't buy unlabeled goods.

The facilities and personnel of the Division are at your service. Call on us when you need us.

SOILS AND FERTILIZERS AND HOW THEY BEHAVE

by
Ivan E. Miles

Were you ever really hungry in your life? I thought I had been until I saw the teaming thousands of Asia. It is said, and I am inclined to believe it, that one-half of the people on earth go to bed hungry every night, and that one-third of them have never had enough of the right kind of food to eat in their entire lives. Their crops and often their animals were in much the same situation. Of course, the hungry animal can break loose and go elsewhere to find food, but, the poor crop has to stay where it's put even though if may starve to death.

Everything including man, animal, and crops has to eat and eat properly if it is to live and fully perform the function for which it was created. At this time, we are thinking of crops. We, who depend upon these crops for a living, should recognize the fact that according to research here in the state, our crops are only half living or at least, only half performing. Over and over again and under many different circumstances, through proper fertilization and management, yields have doubled or tripled the state average and the cost per unit has been materially reduced.

Fertilizers or plant foods are only one part of a total efficient production program called good management. In this paper it will be assumed that all other essential practices will be carried out and, therefore, only soils and plant foods will be discussed.

What Are Plant Foods?

Many elements have been found in crops and at least fifteen are known to be essential. Most of these are present in ample quantities in most Louisiana soils to support good crops, but at least four are needed quite broadly over the state. This includes nitrogen, phosphorus, potash, and calcium or lime. Each of these will be discussed briefly as to their source, function, and behavior.

Nitrogen

The air that we breathe has about 80% nitrogen but this nitrogen, as such, is of no value to general crops. Legume plants with the aid of certain bacteria in the soil can take this nitrogen from the air and use it, but other plants cannot. The natural or unapplied nitrogen in the soil is derived primarily from the organic matter in the soil.

The microscopic, or very tiny, soil organisms in the soil eat and destroy the organic matter in the soil, and in so doing, release the nitrogen which was contained in it. The amount of nitrogen in the organic matter may vary from almost nothing at all up to eight to ten thousand pounds per acre. The figure 2000 pounds per acre used in Figure No. 1 was for illustration purposes.

Golden* has shown that a sugarcane crop ate, or took up, 111 pounds of nitrogen and made about 21 tons of cane. These data suggest that the crop has to actually take up that much nitrogen in order to grow the 21 tons of cane.

How is this nitrogen used in the crop? There are several functions performed by nitrogen, namely:

1. It is the growth element. It stimulates stem and leaf growth.
2. It increases the protein content of the crop.
3. It gives a deep green color to the plant.
4. It increases the water content, thus making salad greens more tender and crisp, and making small grains and rice lodge or fall down worse when excessive amounts are used.

There are several good sources of nitrogen including anhydrous ammonia (82-0-0), urea (45-0-0), ammonium nitrate (33-0-0), ammonium sulfate (21-0-0), and nitrate of soda (16-0-0).

The major portion of the nitrogen is used by most crops in the nitrate form, but some ammonia is used too. This is especially true of the rice crop throughout its life and the cotton crop when it is young. For general crops, the form in which the nitrogen is applied after the soil has warmed up in the spring, is not of very great consequence, however, since the soil organisms soon convert most sources of ammonia to nitrates anyway.

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*L. E. Golden, "Nutrient Availability and Uptake for Sugarcane" memo, Agronomy Department, Louisiana State University, Baton Rouge, Louisiana

Ammonia ties itself to the soil particles and normally does not move a great deal. However, when it is once in the nitrate form of nitrogen it does not tie itself to the soil very firmly and thus moves quite freely with the water. If the soil type is such that the water moves down freely, then the nitrate nitrogen also moves freely and may move out of reach of the plant roots and thus be lost.

On the average, the crop probably does not actually take up more than 50% of the applied nitrogen.

Nitrogen is the most expensive of these plant food elements, but it performs such important functions that it must be used. It pays very handsome dividends when properly used.

Phorphorus

Like nitrogen, the amount of phosphorus as well as the other plant food elements contained in the soil, varies from one extreme to the other. The native or unapplied phosphorus in the soil is contained both on the surface and inside the soil particles as shown in Figure No. 2.

Again Golden's data showed that a 21-ton crop of cane took up 52 pounds of phosphorus. What are the functions of phosphorus in the crop? They are listed below:

1. It is the fruiting plant food element.
2. It is the plant food that stimulates earliness. It stimulates early root formation, early growth, early fruiting, and early maturity.
3. It is part of every living cell; therefore, it has to do with reproduction.

There are also several sources of phosphorus. These include fused tri-calcium phosphate(0-27-0), calcium metaphosphate (0-62-0), rock phosphate (0-32-0), super-phosphate (0-20-0 and 0-45-0), ammonium phosphate (11-48-0) which is relatively new and is water soluble, ammoniated phosphate (the regular or conventional type of mixed fertilizer like (8-8-8), and phosphoric acid or liquid phosphorus (0-[52-54]-0).

The efficiency with which applied phosphorus is used varies a great deal with the type of pH of the soil, the source, the crop, and the method of application. The greatest efficiency for row crops is normally realized when a highly soluble (ammonium phosphate) phosphate material is banded in the row on a sandy to sandy loam soil that has a pH of 6.0 to 7.5. Under very acid conditions, some of the other sources would be just as efficient, if not more so.

The efficiency of the most soluble forms and under ideal conditions would normally not exceed about 30 to 35% of the applied phosphates. Not over 15 to 20% efficiency is realized on much of the phosphorus applied in Louisiana.

When phosphorus is applied to the soil it ties itself to the minerals in the soil and tends to become rather firmly fixed as to both compound formed and position in the soil. It then becomes less soluble, less active, and moves little or none in the soil. More acid conditions accelerate this action as shown in Figure No. 3. This reaction condition is more pronounced in clay soils than in sandy soils. In the case of the more soluble phosphates and particularly for row crops, banding the material is considerably more efficient than broadcasting. A minimum of contact between the soil particles and the phosphorus material retards this tying up or fixation process. On the other hand, broadcast application would give maximum contact between soil particles and phosphorus material and would accelerate fixation of soluble phosphates.

Phosphorus is an extremely important plant food. There is a great deal of difference in different sources and this should be recognized and the phosphorus selected and used in such a manner to realize the greatest profit.

Potash

This plant food element is contained in the soil particle in relatively larger amounts than phosphorus. It becomes available to the crop whether it is derived from the soil or applied fertilizer, as it dissolves in the film of water around the soil particles.

In the case of potash, Golden's results showed that a 21-ton crop of cane used 212 pounds. Potash performs a number of very important functions in the plant, namely:

1. It is the general health and vigor element. It tends to make the crop strong and vigorous, enabling it to stand more cold weather, to have a strong, stiff stalk and thus not blow down easily, and to resist certain types of diseases.
2. It is an important quality element. For example, vegetables with ample potash tend to be more firm and thus reach the market in better condition.
3. Stimulates root formation.

There are several sources of potash including muriate of potash (0-0-60), sulfate of potash (0-0-48), and sulfate of potash - magnesia (0-0-25).

When potash is added to the soil it tends to tie itself to the soil complex, but it is not fixed as firmly as phosphates. In very sandy soil where the soil water can move down rapidly, the potash can go into solution and be leached out and lost. In loams and clays where the movement of water is restricted, not much potash is normally lost by leaching.

The efficiency with which applied potash is used by the crop is somewhat in the same category as nitrogen. Under ideal conditions, recovery of applied potash may run as high as 80 to 85%, but on the average, probably not over 50 to 60% is utilized by the crop.

Calcium

The native or unapplied calcium is contained in the soil particle. The amount of calcium contained in the soil may vary from nothing to many tons in the top soil on each acre.

The end product of applied calcium in the soil is calcium carbonate or lime. Therefore, whether it is applied to the soil as calcium oxide (burned lime), calcium hydroxide (hydrated lime), or as calcium carbonate (lime), the end product is calcium carbonate.

Calcium serves several very important functions, namely:

1. It is an important plant food. Its exact functions are not fully understood. It is believed that calcium aids in:
    - A. Translocation of carbohydrates within the plant.
    - B. Construction of healthy cell walls.
    - C. Assists potassium and magnesium in neutralizing organic acids within the plant.
2. It is the predominant element that control pH in soils that are used for cropping purposes. A favorable pH increases efficiency in usage of other plant foods.
3. It makes a favorable media in the soil for soil organisms to work.

A good supply of calcium is needed in all cultivated soils in order to realize the greatest efficiency from the other plant foods and to produce food and feed of high quality.

Soil Testing

As already pointed out, nitrogen, phosphorus, potash, and calcium are all very important plant food elements. Each one performs a separate and distinct function. Neither one of them will do the work of any of the others. All must be present and available in sufficient quantities if the crops are to grow and produce efficiently.

The amount of nitrogen, phosphorus, and potash that is utilized in growing various crops is pretty well established and some of them are shown below:

PLANT FOOD REMOVAL BY CROPS

CROP	YIELD	NITROGEN	PHOSPHORUS P_2O_5	POTASH K_2O
Cotton	1-1/2 bales	105#/A.	45#/A.	64#/A.
Corn	100 bushels	160	60	120
Sweet Potatoes	300 bushels	75	20	115
Tomatoes	20 tons	200	80	400
Alfalfa & Grass	4.5 tons	170	45	200
Soybeans	4.0 bushels	180	45	80

How is the farmer to know whether his soil has enough available plant food to produce the type, kind and amount of production that he wishes? There are a number of aids in arriving at the answer to this question. A crop which is hungry for nitrogen gives certain symptoms, phosphorus others, and potash still others. Studying these hunger signs in crops can be very helpful in determining plant food needs. Fertilizer experiments and demonstrations can also be very helpful. Plant tissue tests properly run and interpreted can supply some very helpful information too.

For most farmers though, a soil test based upon a good sample and accompanied by the basic historical data on that soil and on the crops grown on it, is perhaps the best tool available. The results of the tests can best be interpreted by someone trained in soil chemistry and plant nutrition and with a knowledge of local conditions.

A new soil test should be made every three or four years. A systematic program of testing soils should be practiced by all farmers.

Figure 1

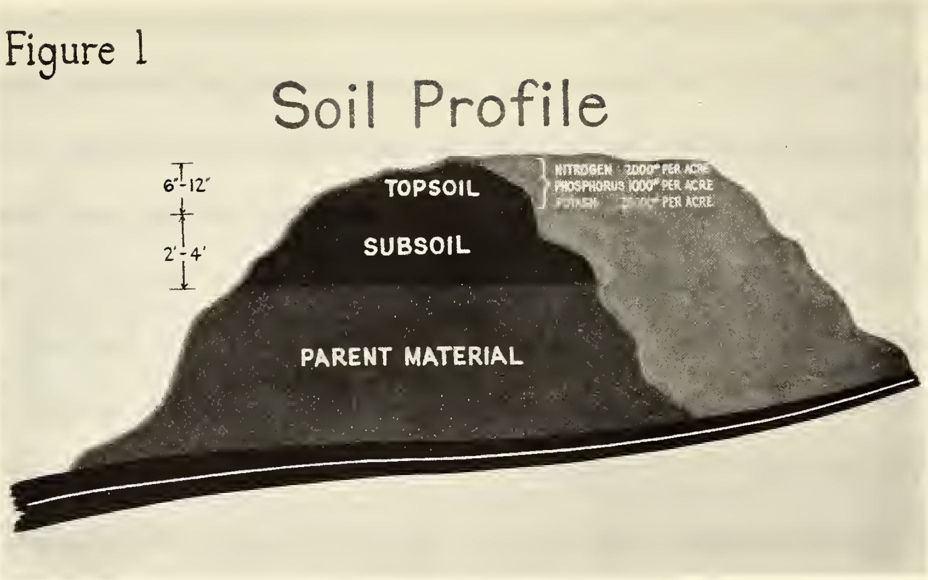


Figure 2

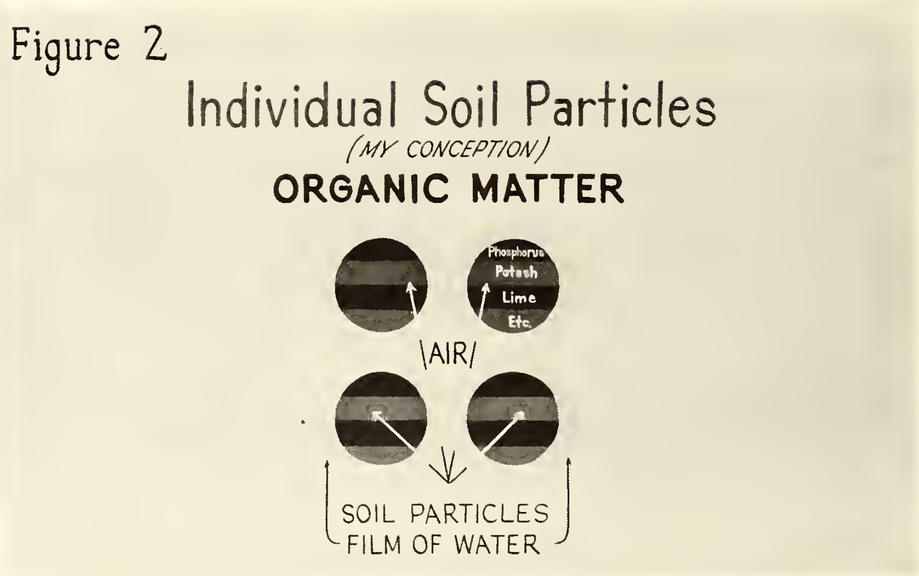
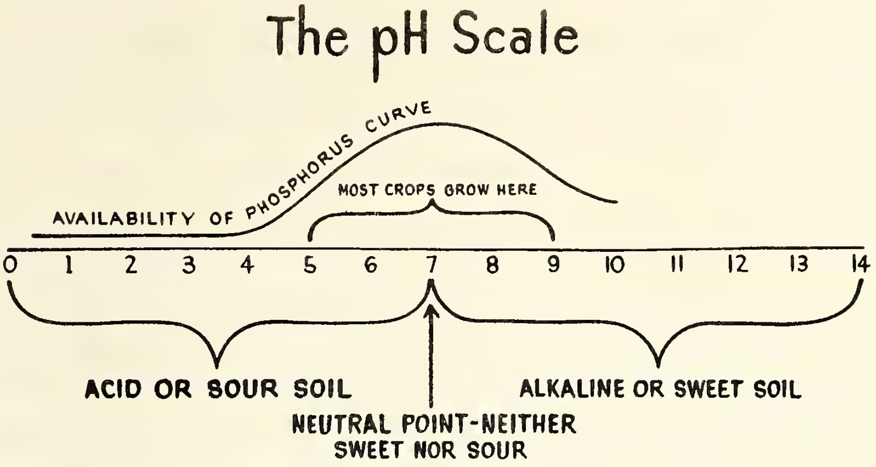


Figure 3


The pH Scale
AVAILABILITY OF PHOSPHORUS CURVE
MOST CROPS GROW HERE
ACID OR SOUR SOIL
ALKALINE OR SWEET SOIL
NEUTRAL POINT-NEITHER SWEET NOR SOUR

THE FARM AND HOME DEVELOPMENT PROGRAM AND ITS EFFECT ON SOME IBERIA SUGARCANE FARMERS

Charles A. Miller

The rapid technological advancement and economic growth which our country has experienced during the past two decades has, in general, resulted in chronic economic pressure for the farmers of our nation. One of the major problems which developed during this period was the "cost-price squeeze" in which farmers found themselves as a result of the inflationary creep in the cost of production and a decline in prices received. Faced with this economic situation farmers and farm organizations throughout the country began to seek and demand assistance with their management problems. Many farmers began to recognize the fact that the rapid changes in Agriculture made it imperative that they do more and better planning.

Approximately 7 or 8 years ago as a result of these requests from interested and concerned people, the Agricultural Extension Service inaugerated a new educational method of working with farm families. In Louisiana and most states, the program is called "Farm and Home Development." It is known as "Balanced Farming" in Missouri and other names in some states. The objectives of Farm and Home Development are to teach farm families to understand and develop skills in use of principles and procedures of management that will enable them to analyze their situations, explore opportunities, make decisions, develop plans and carry the plans to a successful conclusion -- with the ultimate goal in most cases being increased net income for improved family living. Families participating on the program counsel individually with Extension Agents and emphasis is given to studying the problems existing on that particular farm.

All over the United States, County and Associate County Agents have the major responsibility for the production phase of Farm and Home Development in their counties or parishes. In most cases, this is a full-time job. The Home

Demonstration Agents are responsible for the home management phase of the program in the counties or parishes where this program is in effect.

In 1954 the program was first started in a few parishes in Louisiana and presently is in operation in 22 Louisiana parishes. While Farm and Home Development is concerned with the farm from both the home and business viewpoint, my discussion today will be concerned only with the farm business or farm management aspect.

Income on many Louisiana farms is often lower than it could be. This situation is also typical of many farms throughout the country. Agricultural research, education, policy and major efforts of various agricultural agencies, have been directed toward improving farm income for many years. This relatively new national educational program is another method aimed at assisting farm families adjust to the problems of a rapidly changing technological age.

There are two main reasons why incomes on many farms are often lower than they should be: First, unprofitable practices, and, second inefficient organization of the farm business or farm resources. In many cases either or both may need improving. PRACTICES have to do with such things as land preparation, seeding, fertilization, weed control, insect control, etc. ORGANIZATION has to do with the way in which the farmers' resources and products are combined. Some farmers often follow costly or unproductive ways of doing things on the farm when less costly or more efficient means are available. The organization of inputs may be poor. There may be over capitalization (in the form of too much equipment), or too much labor, or imbalance in the form of capital being used -- such as too much equipment, but not enough fertilizer.

An inefficient combination of enterprises may be causing competition between resources such as labor and machinery at critical periods. Other times these same resources are lying idle when they could be put to use on something else. These and similar kinds of problems are MANAGEMENT PROBLEMS on individual farms. Often they can be improved by studying the farm from a business standpoint, making sound corrective decisions, and then putting these decisions into action.

Agents assigned to Farm and Home Development Program work with as many families as effectively possible, which will usually be 60 to 80 families. Participating families are selected from various parts of a parish or county so that practices which they adopt can be disseminated to as many people as possible. Only those showing interest in the program and a desire to cooperate are selected. Farm and Home Development is designed for all types and sizes of farms. The size of the farm is not a determining factor, however, each family selected should have the potential to develop an economically sound farm business.

Since the objective of the program is to increase net farm income by improving management this usually means changing practices or organization of the farm, or both. Potential cooperators who have indicated an interest in the program either by contacting the county agent or whose names was submitted by a member of the Extension Advisory Committee or a neighboring farmer is paid an initial visit by the agent to explain the aims and objectives of the program. The farmer is told about the type of assistance he can expect -- including visits from the agent periodically to follow-up on recommendations made to him -- not so much to check and see if he carried out the recommendations, but to see if recommended practices were effective. The farmer is also told that he will be given assistance with records and will be expected to keep an adequate record of his operations.

Once it has been mutually agreed that a farmer wants to participate on the program, the farmer and agent will get together to make an inventory of the kinds and amounts of resources he has to work with, including land, labor and capital. This includes a map of his farm layout, showing slopes, drainage, etc. Then the various production practices which he has been following such as seeding and fertilization rates, disease control, insect control, etc. are carefully examined. The current organization of resources and the combination of products are also studies for flaws. There may be too little or possibly too much machinery. Labor or land may be under utilized. Crops may be competing with one another for labor or machinery at a critical period so that production suffers. In some cases more land may be needed to make better use of equipment and available labor. Various other evidences of poor management may show up which may often be improved.

Having done this the next step is to do the "budgeting" which is nothing more than planning, on paper and in advance, how the farm's resources will be used and what the alternative production possibilities are open to the farm. This budgeting technique makes it possible to test various alternative farm plans and practices on paper with a fair degree of accuracy. The plans or "budgets" as they are called are based on the best data available at any given time -- such as experiment stations, specialist, farm records, surveys other farmers -- in short, many sources.

This process provides an excellent opportunity for the farmer to sit down and take a good look at his business -- to evaluate his present operation, look into the possibility of making constructive changes and plan a definite course of action.

At the end of each year the records of the farm operations are examined and analyzed. In many instances an analysis of the records will reveal weaknesses in the previous year's operation which can sometimes be corrected the following year. One of the values of this program, I believe, is that the paper work involved, such as the farm inventory, budgeting, records, etc., develops a more businesslike attitude among the participants -- a factor which is becoming increasingly important in modern day farming.

In 1957, after 8 years of doing 4-H Club work in Iberia Parish I was assigned to the Farm and Home Development Program. Mr. Williams, the County Agent, had been working with 5 families for approximately 3 years prior to this time, however, it was not until September of 1957, when I was given the responsibility, that a full-time agent had been assigned to this program in Iberia. Twenty-two families were enrolled the first year and each year, thereafter, additional families were added to bring the present total to 70. Among these are 45 sugarcane growers, 15 dairymen and several rice, cotton and livestock farmers.

Following are a series of charts showing the changes in inventory income, and yields which occurred on the sugarcane farms during the five year period 1957-1961. These figures were taken from actual records kept by the farmers participating on the program.

(Table 1)

INVENTORY PER FARM (Excluding land)

AVERAGE	1957	1958	1959	1960	1961
(All sugarcane farms on program)	$17,637.99	$19,026.38	$19,194.40	$20,986.59	$23,024.61

The average investment (excluding land) per farm for all farmers enrolled on the Farm and Home Development program increased from $17,637.99 in 1957 to $23,024.61 in 1961, reflecting an average increase in investment per farm of $6,240.92 or 30 per cent.

(Table 2)

AVERAGE GROSS INCOME

(5 Year Period)

	1957	1958	1959	1960	1961
Group I (20-50 Acres)	$ 5,338.52	$ 6,579.79	$ 7,122.08	$ 7,380.44	$ 8,601.83
Group II (50-100 Acres)	7,993.55	14,706.36	11,859.06	12,703.77	17,135.81
Group III (100-200 Acres)	20,087.49	25,821.30	29,015.06	30,976.70	42,003.93
Group IV (Over 200 Acres)	37,001.23	49,095.32	56,865.17	71,675.34	87,113.05
AVERAGE	$17,605.19	$24,050.69	$26,215.34	$30,684.06	$38,713.65

In an effort to group the farms as closely as possible according to size of operation they were divided into four categories. Group I represents farms growing between 20-50 acres of sugarcane; Group II 50-100 acres; Group III 100-200 acres and Group IV over 200 acres.

Over the five year period 1957-1961 the average gross income per farm (all groups) increased from $17,605.19 in 1957 to $38,713.65 in 1961 or 120 per cent. The category showing the least increase in gross income during this period was Group I which had an increase of 61 per cent. The largest increase in gross income per farm was shown by Group IV which had an average increase of 135 per cent.

During this period there was a 35 per cent increase in acreage for all farms participating on the program.

(Table 3)

FARM INCOME

(Cash Income Over Cash Expenses)
(Average Per Farm)

	1957	1958	1959	1960	1961
Group I (20-50 Acres)	$ 2,508.71	$ 3,426.65	$ 3,427.08	$ 3,808.58	$ 4,664.26
Group II (50-100 Acres)	2,356.95	6,432.27	5,289.02	5,410.65	8,725.49
Group III (100-200 Acres)	5,845.17	8,166.17	8,725.38	11,926.68	16,378.38
Group IV (Over 200 Acres)	955.54	12,261.44	14,888.83	22,812.72	31,037.55
AVERAGE FARM INCOME	$ 2,438.82	$ 7,571.63	$ 8,082.57	$ 10,989.65	$ 15,201.42
AVERAGE NET INCOME	675.03	5,669.00	6,163.13	8,891.00	12,898.96

During the five year period 1957-1961 average farm income (figured by substracting cash expenses from gross income) increased from $2,438.82 to $15,201.42, representing an increase of approximately 500 per cent. Group I with an increase of 86 per cent showed the smallest increase of all groups. Group IV which progressed from a loss of $955.54 per farm in 1957 to an average farm income of $31,037.55 in 1961 showed the largest percentage of increase.

NET INCOME (after depreciation) - Using a straight line 10 per cent depreciation average net income of all groups increased during the same period from $675.03 in 1957 to $12,898.96 in 1961.

(Table 4)

AVERAGE YIELD PER ACRE

(5 Year Period)

	1957	1958	1959	1960	1961
Group I (20-50 Acres)	21.1	26.8	22.7	21.8	27.4
Group II (50-100 Acres)	19.1	25.9	21.6	22.1	29.1
Group III (100-200 Acres)	18.6	26.6	24.7	22.7	29.1
Group IV (Over 200 Acres)	18.7	25.1	24.0	27.2	32.3
GROUP AVERAGE	19.4	26.1	23.2	23.4	29.4
PARISH AVERAGE	18.1	23.7	20.9	20.1	26.4

In 1957 the average yield of all farmers enrolled on the program was 19.4 standard tons per acre. In 1961 the average yield per acre was 29.4 standard tons, an increase of 10 tons per acre of 52 per cent over the five year period. Not all categories, however, experienced the same rate of increase. The average per acre increase for Group I was 6.3 tons; Group II 10 tons; Group III 10.5 tons and Group IV 13.6 tons.

In comparing the above yields with the parish average, ASC records show that in 1957 the average yield per acre in Iberia Parish was 18.1 standard tons. In 1961 the parish average was 26.4 standard tons or an average increase of 46 per cent over 1957.

Each year Farm and Home Development cooperators produced an average of from 1.3 to 3.4 more standard tons per acre than the parish average.

AVERAGE FARM INCOME PER ACRE

(Cash Income Over Cash Expenses)

1957	1958	1959	1960	1961
$33.69	$85.59	$69.71	$88.44	$107.51

AVERAGE NET INCOME PER ACRE

1957	1958	1959	1960	1961
$21.09	$56.64	$50.99	$66.63	$81.85

SUMMARY AND CONCLUSION

Over the five year period as average yields increased, average net income per farm also increased. Group IV (farmers growing over 200 acres of sugarcane) showed the largest percentage of increase in farm income. This same group also had the largest average yield per acre increase during this period. Within this period of time comparing 1958 with 1959 there was an actual decrease in yield of 2.9 tons per acre, however, average net income increased by approximately $500.00 per farm.

Average net income in 1960 increased $2,737.87 over 1959 although the increase in yield was only .2 of a ton per acre.

The purpose of this presentation was certainly not an attempt to convince you that the Extension Service (Farm & Home Development Program) was entirely responsible for all the improvement shown by the farmers enrolled in this program. I sincerely hope that I haven't left you with this impression. Many of these farmers were progressive minded and would undoubtedly have increased their efficiency regardless of whether they were participating on this program or not. Weather conditions certainly also played an important part in determining yields.

I do believe, however, that this type of educational approach effected a significant influence on the progress shown by these farmers over this five year period. It is reasonable to believe that each individual taking time out to study the problems peculiar to his particular farm and outlining a specific plan of action would improve his chances of making profitable decisions. Record keeping and analyzing results at the end of each year's operation certainly added a businesslike approach which is becoming increasingly important in modern day farming.

A STUDY OF METHODS OF CANE QUALITY DETERMINATION
FOR
CANE PAYMENT

John J. Seip
Chemical Engineering Department
Louisiana State University

Increasingly, cane payment based on the quality of the cane entering the factory is becoming general throughout the sugar cane growing areas of the world. Among the factors responsible for this is the growing volume of cane supplied to the factories by the independent cane farmers - and their greater participation in the affairs of the industry. One result of this has been emphasis on cane payment systems which relate the quality of the cane to the price paid for the cane.

In recent years - on a world wide scale - the sugar industry has engaged in extensive research to establish workable methods of cane quality determination to serve as bases for cane payment. In Louisiana - for the past fifteen years - the LSU Chemical Engineering Department in cooperation with the industry has conducted studies at the Audubon Sugar Factory on methods of sampling, testing and evaluating sugar cane.

Concurrently with the pilot and plant scale studies, the LSU investigations have included rather comprehensive literature surveys and correspondence with representatives of the industry on methods of cane quality determination in the various cane growing areas of the world. The philosophy behind this phase of the research has been that in understanding the overall problems and experiences of others, we are better able to assess the problems in cane quality determination which may be peculiar to Louisiana.

I would like to review this phase of the LSU studies today - that is - some of the methods of cane quality determination for cane payment which are used in other cane growing areas of the world.

In the subject of cane quality determination, we are including the whole aspect of (1) sampling or withdrawing the sample, (2) testing to include analyzing the sample, and (3) evaluating the results in terms of the quality of the cane.

The factors of sampling, testing, and evaluation are all inter-related. A detailed test procedure is of questionable value if the sample is not representative of the complete shipment. By the same token, effort is wasted in careful sampling if the test procedure is not reproducible. Finally, the measure of cane quality as evaluated must bear some relation to the actual commercial value of the shipment.

In reviewing the different methods of cane quality determination it is well to recognize that they are all conditioned by circumstances peculiar to the area. Some areas have a high incidence of very small farming operations while other areas represent essentially large factory cane growing enterprises.

While most areas still hand harvest the cane, increasingly mechanical loading and to a lesser extent mechanical harvesting are practiced.

Finally, although some form of government regulation of the industry is fairly universal, such control is of varying degree, extending at one extreme in some areas to government supervisors in each of the factories to oversee the cane quality determination, to the other extreme of self-regulation by agreements among the farmers and the factory owners - with a minimum of government control.

In discussing specific methods of cane quality determination, they all seem to break down into two main categories. We are all familiar with the system of crusher samples - a system in which cane is sampled in the carrier. Such determinations may be extended to include fiber determinations from the shredded cane in the carrier or from stalks of cane removed from the carrier.

We shall refer to this as indirect cane quality determination.

More recently, extensive studies have been directed toward determining the quality of the cane from a sample removed before the cane enters the carrier. Such studies had their natural origin in agronomic research, which was directed to determining the yield of the cane in the field. However, the growing incidence of mechanical harvesting and loading - with the resultant trash and soil accompanying the cane - has resulted in an increased frequency of cane washing installations throughout the industry. The resultant dilution of the crusher juice has made subsequent crusher juice inspections of doubtful value. The logical recourse has been to analyze the cane before it enters the carrier. By general usage, cane quality studies directed towards evaluating the cane before it enters the carrier or the milling process have been classified as direct cane quality determination.

In reviewing the cane quality determination systems we shall refer to the standard of cane quality. This is the unit which is used to define the quality of the cane. In Louisiana we use Normal Juice Sucrose and Purity.

We shall also refer to the cane quality formula. This is the formula to evaluate the cane in terms of the standard of cane quality. Generally, the formula equates some readily measureable quantity as the crusher juice inspections and possibly fiber - to the standards of cane quality.

South Africa

The use of the Java Ratio to evaluate cane is probably the oldest and simplest method of indirect cane quality determination. The Java Ratio is defined as:

$$\text{Java Ratio} = \frac{\text{Sucrose \% Cane}}{\text{Sucrose \% Crusher Juice}}$$

The Java Ratio is used in South Africa where the standard of cane quality is sucrose % cane. Samples of crusher juice from the consignments of cane are tested for apparent sucrose, and the results are applied to the cane quality formula.

$$\text{Sucrose \% Cane} = \begin{matrix}\text{Sucrose \%}\\ \text{Crusher}\\ \text{Juice}\end{matrix} \times \text{Java Ratio}$$

The Java Ratio is determined weekly from the factory control data. The crusher juice inspections for each grower are averaged for the corresponding week.

Jamaica

In Jamaica, the purity of the crusher juice is incorporated into the formula - along with the Java Ratio and the crusher juice sucrose - to obtain cane quality in terms of recoverable sugar. The standard of cane quality is Tons of Cane per Ton of 96° Sugar, TC/TS. The cane quality formula is:

$$\left[\frac{TC}{TS}\right]_{\text{Farmer}} = \frac{\left[\begin{matrix}\text{Sucrose \%}\\ \text{Crusher}\\ \text{Juice}\end{matrix} \times \begin{matrix}\text{W. C. Retention}\\ \text{@ Crusher Juice}\\ \text{Purity}\end{matrix}\right]_{\text{Factory}}}{\left[\begin{matrix}\text{Sucrose \%}\\ \text{Crusher}\\ \text{Juice}\end{matrix} \times \begin{matrix}\text{W. C. Retention}\\ \text{@ Crusher Juice}\\ \text{Purity}\end{matrix}\right]_{\text{Farmer}}} \times \left[\frac{TC}{TS}\right]_{\text{Factory}}$$

The factory TC/TS is based on actual factory performance.

$$\left[\frac{TC}{TS}\right]_{\text{Factory}} = \frac{1}{Y}$$

and

$$Y = S \times JR \times E \times R_{\text{Theo.}} \times BHE \times K$$

where: Y is the yield of 96° sugar per ton of cane.

S is the sucrose % crusher juice.

JR is the Java Ratio, $\frac{\text{Sucrose \% Cane}}{\text{Sucrose \% Crusher Juice}}$

E is the mill sucrose extration.

$R_{\text{Theo.}}$ is the Winter-Carp theoretical retention.

BHE is the boiling house efficiency.

K is the factor for conversion of sucrose in sugar - at the actual purity of sugar - to 96° test sugar.

From these formulas, it is evident that the farmer's payment is factored to the efficiency of the factory. In other words, his cane quality in terms of recoverable sugar is dependent on the factory recovery of sugar.

Philippines

The system in the Philippines is similar to that of Jamaica in that the Java Ratio is used along with the purity of the crusher juice to determine cane quality in terms of recoverable sugar. However, some of the factories use specific standards of factory extraction and retention. In this manner, the farmer's payment is independent of the factory efficiency.

The standard of cane quality is Piculs of Sugar per Ton of Cane. (A picul is about 133-1/2 pounds.) The cane quality formula is:

$$\frac{\text{Piculs of Sugar}}{\text{Ton of Cane}} = \text{Sucrose \% Crusher Juice} \times \text{Factor}$$

$$\text{Where Factor} = \frac{\text{Piculs of Sugar}}{\text{Ton Cane, Unit Sucrose \% Crusher Juice}}$$

The factor is expressed as follows:

$$\text{Factor} = JR \times E \times \frac{S(J-M)}{J(S-M)} \times BHE \times \frac{1}{PS}$$

Where: JR is the Java Ratio, $\frac{\text{Sucrose \% Cane}}{\text{Sucrose \% Crusher Juice}}$

E is the sucrose extraction.

J is the purity of the mixed juice.

M is the gravity purity of the molasses.

S is the gravity purity of the sugar.

BHE is the boiling house efficiency.

PS is the polarization of the sugar.

Tables of factors are worked out to express the yield for corresponding crusher juice purities.

Reunion

The Reunion method of Indirect Cane Quality Evaluation is of interest because it has been recently developed and is based on a thorough and rigorous treatment of the conventyional extraction and retention formulas.

This method is based on absolute juice in the cane (cane minus fiber) and thus requires fiber determinations in addition to the crusher juice analyses.

The standard of cane quality in Reunion is SE, which is defined as the commercial raw sugar of 97° titre % cane that should be obtained from a cane delivery, by a factory of 95% reduced extraction and 100% boiling house efficiency, and with a standard or ideal molasses purity (Titre = sucrose -2 x glucose -4 x ash). The cane quality formula, which was developed by E Hugot, is expressed as follows:(1)

$$SE = K \times B_1 \frac{(P_1 - 30)}{(\ 100\ )} (1-1.4f)$$

Where: SE is the commercial sugar of 97° titre % cane.

B_1 is the Brix of the first expressed juice.

P_1 is the purity of the first expressed juice.

f is the parts of fiber per 100 parts of cane.

K is the Factory Efficiency Coefficient.

The absolute juice quality is inferred from the crusher juice inspections and the fiber content of the cane. Fairly fixed ratios of the first expressed juice and absolute juice Brix and purities are assumed. These ratios are incorporated in K, the Factory Efficiency Coefficient. The stand extraction is a 95% reduced extraction at 12.5% fiber. The standard retention is developed through the use of the SJM formula and a boiling house efficiency of 100. Final molasses purity is about 29.

In applying the formula, the Factory Efficiency Coefficient, K, is determined at the end of the crop by dividing the average factory SE by the average growers' "theoretical" SE (SE from the formula without the factor K). Limits are set on the Factory Efficiency Coefficient to protect the grower from the inefficient factory, and to permit the efficient factory to rapidly recover its investment in equipment to improve its efficiency.

Queensland

Queensland too incorporates fiber in its determination.

Among the cane growing areas which early recognized that the determination of cane quality is a necessary adjunct to an equitable cane payment system, Queensland is probably best known for the indirect CCS system. CCS (Commercial Cane Sugar) is the standard of cane quality, and is defined as that percentage by weight of a shipment of cane which would be recovered as pure sucrose if milling and boiling house operations were conducted at a prescribed level of efficiency. The CCS formula, devised in 1888 and incorporated in the original 1915 industry control regulations, states in its simplest form that the sucrose recoverable from a given quantity of cane (CCS) is less than the sucrose present in the cane by an amount equal to one half of the soluble impurities in the juice in the cane.

$$\text{CCS} = \begin{array}{c}\text{Sucrose}\\ \text{in Cane}\end{array} - \frac{\begin{array}{c}\text{Dissolved Impurities}\\ \text{in cane}\end{array}}{2}$$

The cane quality formula as developed from this basic assumption is:

$$\text{CCS} = \frac{3}{2} P \left[1 - \frac{F + 5}{100}\right] - \frac{1}{2} B \left[1 - \frac{F + 3}{100}\right]$$

Where: P is the apparent sucrose (pol) % first expressed juice.

B is the Brix % first expressed juice.

F is the fiber % cane.

For many years the CCS formula was applied directly to determine the quality of the planters' cane. Fiber values were those which had been determined previously by variety, whether plant or ratoon cane, and whether burned or "green." This was known as the Front Roller Juice - Stick Fiber CCS.

With the advent of juice scales and the subsequent more precise chemical control, inadequacies began to appear in this method. Particularly evident were discrepancies between undetermined losses by the juice scales and those based on the CCS method currently in use. This trend was aggravated by mechanization of harvesting operations in some areas and delay between burning and milling of cane.(2)

Several factories subsequently used an amended CCS system which incorporated revisions in the method of determining fiber, and permitted the juice scales to be used as control to determine a corrected CCS. Under the amended system - known as the Individual Fiber and Juice Weight CCS - weekly fiber determinations are made for the individual planters and a weekly factory CCS is determined which is based on the measurement of the cane, maceration water, and mixed juice. A weekly correction factor is determined relating the factory CCS to the average planters' CCS as determined from the CCS formula. This factor is then applied to the individual planter's CCS to get a corrected CCS for each planter.

Direct Cane Quality Determination Methods

The discussion so far has dealt with indirect methods of cane quality determination - that is, determination of the quality of the cane in the carrier. These methods all require crusher juice samples. The expedient of washing the cane in the carrier in response to mechanization of the harvesting operations has made crusher juice inspections of doubtful value. The recourse has been to methods of sampling the cane before it enters the carrier, i.e., direct cane quality determination.

Two methods of testing are of interest. In the cold water extraction process, the cane sample is disintegrated and sub-sampled. Weighed portions of the sub-sample and tap water are vigorously agitated in a container which is equipped with rapidly rotating blades. The residue and extract are then analyzed to determine the sucrose, Brix, and fiber percent cane.

Among the cold water extraction methods of interest are the Wet Disintegrator method in Queensland,(3) the South African Cold Extraction process,(4) and the Hawaiian Pol Ratio method.(5)

The other method of direct cane quality determination is the use of the three-roll sample mill, with which we are all familiar in Louisiana, and which forms the basis for the cane payment systems in most of the Louisiana factories.

For many years the three-roll sample mill has been used in agronomic research at the Houma Experiment Station of the United States Department of Agriculture. Through these studies the Sx-By cane quality formula was developed.

$$Y = Sx - By$$

Where: Y is the yield of 96° sugar per ton of cane.

S is the sucrose % first expressed juice.

B is the Brix % first expressed juice.

x and y are factors which incorporate reduction factors - relating the quality of the first expressed juice to that of the normal juice, the normal juice extraction, and an assumed boiling house efficiency.

Arcenaux and Hebert have extensively reviewed this system in the technical literature, and Dr. Arcenaux discussed its possible application to cane payment systems before the February 1960 meeting of the American Society of Sugar Cane Technologists.(6)

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THE EFFECT OF SHAVING SUGARCANE ON INCOME

by

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Assumption Parish

As County Agent it is my duty to provide farm people with useful and practical information and to encourage the use of that information for better farming and a better life on the farm.

In the fulfillment of this responsibility it was my duty to bring the research information available on shaving sugarcane to the growers I am working for and to encourage the use of this information.

Shaving sugarcane consists of cutting back in the late winter or early spring the above-ground growth with a horizontally revolving disc cutter. The reasons for shaving are: (1) removing growth of winter cover crop on plant cane, (2) to remove stubble with poorly cut high stumpage and (3) to clean the top of the row. The practice of shaving sugarcane has been for generations in Assumption Parish and Louisiana.

The County Agent's main source of providing farm people with information is from research findings. In following this procedure, Dr. Leo Hebert, Research Agronomist Division of Sugar Plant Investigation, United States Department of Agriculture, has found the following on the Effect of Shaving on Sugarcane Yields.

RESULTS OF SHAVING EXPERIMENTS ON SUMMER PLANT CANE DURING 1950 BY DR. HEBERT

Average yield decrease due to Shaving - Summer Plant Cane

	Time of Shaving			Average of all dates
	Feb. 10	Feb. 20	Mar. 10	
Cane per acre (tons)	6.42	6.35	6.84	6.53
Sugar per ton of cane (pounds)	3.50	4.60	3.90	4.00
Sugar per acre (pounds)	1292	1313	1380	1328

Average yield decrease due to shaving

	Plant Cane	First Stubble	Second Stubble
Cane per acre (tons)	6.11	11.75	8.53
Sugar per ton cane (pounds)	16.6	9.00	10.8
Sugar per ton (pounds)	1898	2670	2078

Summary by Dr. Hebert

Results of shaving tests on sugarcane in Louisiana during the period 1947-50, inclusive, show that:

1. Shaving of plant cane constantly depressed yields of plant cane, and was especially harmful in the case of late shaving with August planted cane.
2. Residual effect of shaving plant cane on first stubble yields cannot be established on the basis of present information but results indicate a probably harmful effect in the case of summer plant cane.
3. Shaving had no measurable effect on indicated yields of sugar per ton of cane in tests conducted prior to the unusually mild winter of 1949-1950.
4. Shaving is much more injurious in some years than in others, and especially as following unusually mild winters.

The above information was presented to approximately 75 per cent or 175 of the sugarcane growers of Assumption Parish at a parish-wide meeting in the spring of 1954 by Dr. Hebert. The information presented on shaving caused a considerable amount of discussion but very little action. Only two growers in the spring of 1955 left some cane unshaved. The two growers were pleased with the unshaved sugarcane, therefore, the following season they and a few other growers left some sugarcane unshaved. More than 60 per cent of the 1961 sugarcane crop was not shaved.

To get some local information on the effect of shaving on sugarcane yield, four sugarcane growers agreed to work with the County Agent in 1961.

The four growers selected did most of the work themselves required in the cultivation and in the harvesting. Johnson grass nor any other grass were a problem on these farms.

Four rows were shaved and the next four rows were used as checks. There were two replications in each experiment.

The sugarcane was cut with a cane cutting machine. Following the cutting a representative sample was taken by the County Agent. The samples were analyzed by the factory buying the sugarcane.

The sugarcane was weighed at the farm hoist equipped with a scale.

The local ASC office was used in figuring acreage in each plot and evaluating the sugarcane.

The results obtained by the Assumption growers were as follows:

Jim Templet -- 47-193 Plant Cane
Shaved March 10th

	Tons Per Acre	Sucrose	Purity	Value Per Acre
Not Shaved	29.5	12.36	78.88	$245.32
Shaved	24.4	13.09	79.87	204.65
Difference	+5.1	-.73	- .99	+40.67

Paul Landry, Sr. & Sons -- 44-101 Plant Cane
Shaved March 1st

	Tons Per Acre	Sucrose	Purity	Value Per Acre
Shaved	39.8	14.18	83.86	$403.57
Not Shaved	39.3	14.52	85.21	411.08
Difference	-.5	+.34	+1.35	+7.51

Estate Henry Landry -- 48-103 Plant Cane
Shaved March 7th

	Tons Per Acre	Sucrose	Purity	Value Per Acre
Not Shaved	34.6	12.98	80.60	$317.03
Shaved	33.3	13.02	81.03	304.81
Difference	+1.3	-.04	-.43	+12.22

Andre Thibodeaux -- 52-68 Plant Cane
Shaved March 7th

	Tons Per Acre	Sucrose	Purity	Value Per Acre
Not Shaved	37.2	13.72	82.50	$363.49
Shaved	35.7	12.37	79.14	308.07
Difference	+1.5	+1.35	+3.36	+55.42

Andre Thibodeaux -- 36-105 1st Stubble
Shaved March 7th

	Tons Per Acre	Sucrose	Purity	Value Per Acre
Not Shaved	35.1	11.77	77.74	$284.43
Shaved	31.1	11.70	77.69	250.20
Difference	+4.0	+.07	+.05	+34.23

The average income was $30.01 more per acre for the not shaved plots than the shaved plots. These same rows will be shaved as stubble and results obtained.

Remarks: Other benefits from not shaving (1) Cost of Shaving - actual cost for shaving is not available, but we all know that it cost to shave; (2) Stunting disease - our Plant Pathologist reports that stunting disease is spread through the cane juice and shaving is one means of spreading the disease; (3) Covering plant cane - our research people report that too much dirt in covering plant cane effects stands. The grower who does not plan to shave plant cane definitely does not put as much dirt in covering plant cane; (4) Grass control - where Johnson grass is not a problem it seems like summer grass is not as much of a problem when the cane is left unshaved because the cane shades the row earlier.

Growers: The growers are outstanding farmers whose yields are considered above average and who do their own work. What would the difference be for farmers whose shaving is done by hired labor and whose yield is not as high?

PROBLEMS CREATED BY INSECTICIDE USE

by
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Research, Louisiana State University

The use of insecticides for insect control on agricultural crops has greatly increased the quantity and quality of farm produce, particularly during the last two decades. Many fruit and vegetable crops would no longer be acceptable to the average American shopper if insecticides were not used to protect them from insect damage. The wormy apple once on display at the supermarket is now a thing of the past. Because of endrin Louisiana sugar cane farmers are now better able to control the sugarcane borer than ever before.

Since the toxicity of most of the insecticides currently available is not limited to the pests against which they are used, pesticide use frequently has created new problems while solving old ones. Besides the problems which must concern us arising from the toxicity of these chemicals, they may not provide effective pest control indefinitely due to the proven capacity of many pest species for developing resistance to the chemicals used against them.

We will here consider various problems created by insecticide use under the headings of crop residues, soil residues, balance of nature, and resistance to insecticides. Since you are interested primarily in sugar cane production, we will be most concerned with those problems associated with the use of insecticides currently recommended for use on sugar cane in Louisiana, *i.e.* endrin and chlordane.

Crop Residues

Many of our most effective insecticides tend to remain active, under some conditions, when they are no longer needed. This residual nature is characteristic of both chlordane and endrin and is partially responsible for their efficiency as pesticides. However, this same characteristic necessitates care to insure the residues of these chemicals do not remain in food for human consumption.

The American people are well protected from this danger by the Federal Food, Drug and Cosmetic Act of 1938 and by the so called Miller Amendment to this Act which was passed in 1954. This Act of 1938 prohibits the contamination of food by foreign substances, and the 1954 Amendment requires the establishment of residue tolerance levels together with legal machinery for dealing with foods contaminated with excessive residues. There have been no cases of illness in this country from insecticide residues on food when formulations have been used according to directions (Hayes, 1960).

In the case of chlordane and endrin the law requires that these insecticides be used in such manner that no resulting residues will remain in food for human consumption. The Federal Insecticide, Fungicide and Rodenticide Act of 1947, which might be called the labeling law, requires that research be carried out and data presented to show that, if used according to directions, the presticide will produce the biological result claimed and will be safe. Dangers are cited and precautions are clearly stated in the label before it is approved. Labels are not accepted for use on crops until residues have been determined, proper intervals from treatment to harvest set, and tolerance limits established (Hayes, 1960).

It has been generally assumed that compounds having very low solubility in water, such as chlordane and endrin, would not be translocated in plants to an appreciable degree (Westlake and Antonio, 1960). While exceptions to this are know, particularly when some root crops are grown in insecticide treated soil, the assumption generally has been substantiated by research data. There is no reason to believe that the current use of chlordane in sugar cane soils constitutes a crop residue hazard, and residue data were not required under the labeling law in this instance.

Before endrin could be registered and a label issued for its use in 1958 to control the sugar cane borer on sugar cane, samples of raw cane, juice, syrup, molasses, sugar and bagasse were obtained from treated cane for residue analyses. The best existing analytical methods for detecting endrin at that time were not sufficiently sensitive to detect amounts of less than 0.1 part per million (ppm).

The analyses showed that when 4 biweekly applications of endrin were made at the approximate rate of 1/4 pound per acre per application, residues generally did not exceed 0.1 ppm in any of the products sampled except bagasse. Bagasse contained approximately 0.5 ppm 71 days after the fourth and final insecticide application. For this reason your Experiment Station does not recommend endrin for use where bagasse or field trimmings will be used for livestock feed.

After one year of recommended use of endrin on sugar cane additional residue analyses were made of raw cane samples to determine whether the required interval between final treatment and harvest could be reduced below 60 days. Eight 5-pound samples of raw cane taken 30 days after the fourth and final application, and an equal number taken after 45 days all showed less than 0.1 ppm of insecticide residue. On the strength of these data a label change was granted to require an interval of 45 days instead of 60 between final treatment and harvest.

Chlorinated hydrocarbon insecticides tend to accumulate in the fat of animals which feed on materials containing residues of these chemicals. The relative tendencies of these insecticides to accumulate in animal fat have been compared by computing a storage ratio for each chemical (Lehman, 1956). This storage ratio for DDT is higher than that for any other known insecticide, and is such that substantial amounts of this chemical will occur in meat and milk of animals fed forage containing any detectable amount of DDT. Methoxychlor is least dangerous of the chlorinated hydrocarbon group in this respect, and has been considered safe when the dietary level in animal feed is less than 25 ppm.

The storage ratio for endrin has been reported as 15.1 at a dietary intake of 1 ppm (Lehman, 1956). Endrin tends to accumulate in animal fat almost but not quite as much as DDT. Ely _et al_. (1957) found residues of approximately 2 to 4 ppm of endrin on alfalfa hay which had been sprayed with 2.7 to 7.8 ounces of the insecticide per acre one week before cutting. When this hay was fed to dairy cows they produced milk containing between 0.1 and 0.2 ppm of endrin. Long _et al_. (1961) found appreciable amounts of endrin in the fat of lambs which had grazed on a grass pasture treated 6 times with endrin granules at the rate of 1/4 pound of actual endrin per acre per application. Although endrin apparently had no toxic effects on the sheep in this experiment, it was still present in lamb fat in amounts ranging from 6 to 14 ppm 42 days after the animals had been transferred to untreated pasture. For these reasons your Experiment Station does not recommend endrin for use in fields where livestock will be pastured.

One of the biggest problems right now relating to chemical residues in food is that of obtaining a fair and accurate determination of exactly how much insecticide should be tolerated. Many of our effective pesticides today, including endrin and chlordane, have been assigned a zero tolerance which means that no measurable amounts will be tolerated in any food commodity. To many people this is the only sensible approach that can be made to a problem about which so much is yet unknown. However, it will never be possible to completely evaluate all chemicals, before recommending them for commercial use. While zero tolerances presently seem appropriate in many instances, the increasing sensitivity of analytical methods for detecting residues may eventually either force the tolerance of some minute amounts of insecticide residue, or altogether prohibit the use of some of our most effective pesticides.

Phytotoxicity generally has not been an important problem with chlordane or endrin. Chlordane at 2 and 4 pounds per acre has been reported to cause off-flavor in beans, but was not consistently detected. There is evidence that when off-flavor follows insecticide use it is generally caused more by impurities and products of degredation than by the insecticides themselves (Watts, 1955).

Soil Residues

The residual nature of many modern insecticides which are applied to our soils, either intentionally or unavoidably, leads us naturally to wonder how long we can expect to use these chemicals without adversely affecting soil fertility or productivity. The accumulation of sufficient amounts of poisons in the soil could adversely affect soil microorganisms. Of particular importance among the microbes are the bacteria which are largely responsible for converting the "unavailable" nitrogen in organic matter to nitrate nitrogen which is readily available to plants. However, other microbes involved in the total soil microbe complex include actinomycetes, fungi, algae, protozoa and nematodes (Thompson, 1952).

Literature dealing with the effect of modern insecticides on soil microorganisms is relatively scarce. No studies of this sort have been conducted under Louisiana conditions.

Some work on the subject has been done in Utah from which Jones (1956) concluded that the insecticides DDT, chlordane, BHC, aldrin, dieldrin, endrin and methoxychlor are not as toxic to soil microorganisms as to insects. He found that these insecticides were most toxic to nitrifying bacteria which convert ammonia to nitrates. Chlordane was among the insecticides most toxic to the nitrifiers, and began to manifest its toxicity at approximately 200 pounds per acre. Previous studies in Oregon let Bollen (1954) to conclude that field applications of chlordane, BHC, toxaphene or DDT at commonly used rates of application had no immediate harmful effects on soil microorganisms.

French et al. (1959) conducted studies which indicate that soil nematode populations were not seriously affected by DDT, heptachlor or aldrin when these insecticides were applied at rates much higher than those normally employed. However, nematodes are known more for their damage to crops than for any particular function in the soil.

On the other hand earthworms, although they are not microorgranisms, may contribute to plant growth by improving soil aeration and tilth. Earthworms contribute to the formation of soil structure, and their burrows increase the movement of water into and through soils (Clark, 1957). While sharp differences of opinion exist concerning the relationship of earthworms to soil fertility, recent studies in Louisiana by Isa (1961) show that an average of only one-third as many earthworms were found in sugar cane fields 6 to 8 months following the application of chlordane as were found in adjacent plots which did not receive the two-pound-per-acre chlordane treatment.

In addition to the possible long term effects of accumulated insecticide residues on soil microorganisms, similar direct adverse effects on plant growth could result if residues accumulated in sufficient quantities. When 34 varieties of vegetables and flowers were grown in soil which had been mixed with endrin dust to contain amounts of insecticide equivalent to one, two and four pounds per acre, one out of the 34 was retarded in growth by two pounds per acre of endrin and five out of 34 by four pounds per acre (Fleming and Maines, 1953). Watts (1955) states that the stand of most crops is suppressed by 25 pounds per acre of chlordane.

These findings raise many unanswered questions, the most important one being: Could we use endrin and chlordane indefinitely, as they are now recommended for use on sugar cane, without incurring undesirable side effects on soil fertility? To date, research provides no certain answer to this question. However, studies of the rate of insecticide accumulation and loss in soils have been conducted elsewhere. Unfortunately endrin has not been included in most of these studies.

Westlake and San Antonio (1960) have published curves which they believe to be typical of the rates of loss of DDT and chlordane from field soils. Their curves are based on data taken from field plots at Beltsville, Maryland. These curves show that chlordane disappeared from approximately 80 ppm in the soil in 1952 to approximately 55 ppm in 1955 i.e. a 30% loss in 3 years time. DDT was more persistent with a loss of only about 15% after 6 years.

Fleming and Maines (1954) mixed chlordane at the rate of 10 pounds per 3-inch acre with 83 mineral soils from six states and left the soils exposed to weathering. They found that residual chlordane in all soils tended to approach the general averages of 12% after 3 years and 5% after 4 years. A similar study of DDT by the same workers (1953) showed that approximately one-half of the applied DDT remained in the soil after 8 years.

Foster _et al._ (1956) concluded that the probable rate of disappearance of chlordane from the soil when applied at rates of 2 or 3 pounds per acre per year made it extremely unlikely that chlordane residues would ever accumulate in the soil to the extent that the growth of crop plants studied by them would be impaired. However, they also reported that endrin tends to accumulate to about the same degree as DDT. They state that DDT is so persistent as to present a definite hazard to the growth of some crops under some conditions. On the other hand, more recent data from California indicate that the residual life of endrin in soil is considerably shorter than that of DDT, and is more similar to dieldrin, heptachlor, and chlordane (Anderson, 1961).

In addition to the chemical, the type of formulation used, and how it is applied, many other factors are involved in determining the residual life of insecticides in the soil. Soil texture generally has not been cited as a factor of much importance. Organic matter generally is believed to bind insecticides in the soil so that their residues persist longer. However, insecticides bound with organic matter may not exert their toxic effects so readily.

Insecticides are more persistent when they are mixed with the soil than when they are left on the surface. Lichtenstein (1961) believes that there is no need to worry about the accumulation of soil residues as long as insecticides are not mixed with or covered by the soil.

Frequent cultiviation helps to reduce insecticide residues in the soil. Lichtenstein and Schulz (1961) found that daily disking of a loam soil treated with aldrin or DDT at the rate of 4 pounds per acre caused a 25% reduction of DDT residues during a 3-month period. Insecticides are strongly absorbed to dry soils and hence are extremely persistent, while in moist soils they are less strongly absorbed and therefore less persistent (Harris and Lichtenstein, 1961).

The effects of soil temperature, humidity and air movement have also been considered (ibid.). However, the entire problem has not yet received enough study to permit accurate prediction of the residues that will remain after a period of time in any particular place. Nevertheless, if insecticides are used as recommended, i.e. to combat insect infestation after it occurs and not as insurance to prevent infestation, large acreages of land will not be treated unnecessarily, and the relatively small chance of accumulating dangerous residues in the soil will be further reduced.

Balance of Nature

In a talk to a group of sugar producers several years ago, Dr. Newson (1959) said that all insecticides must be capable of upsetting the so-called "balance of nature" or they would not control any insect. This is true today since most insecticides are still relatively nonspecific in their action against a wide range of living organisms. Of course none of these chemicals are equally toxic to all species, and our aim in all insecticide recommendations is to use the smallest amount of material that will effectively control a particular pest. Also, we would like to apply the chemical, if possible, in a manner that will minimize undesirable effects on other species. However, the final decision regarding the justification of any recommendation should rest upon a comparison of the benefits to be derived there from with the losses which may necessarily accompany it.

No one knows the identity of all of the natural enemies of the sugarcane borer in Louisiana. The time honored list including Trichogramma egg parasites, earwigs, and soldier beetle larvae is certainly of academic importance. However, the material benefit resulting from the activities of any one of this group has never been satisfactorily measured. The best information presently available on this subject indicates that ants, including several species, may be our most important natural enemies of the sugarcane borer (Hensley et al., 1961; and other unpublished data).

The use of heptachlor for fire ant control in sugar cane fields convincingly demonstrated the ability of what is probably a complex of predaceous species to exert some natural control over borer populations (Long et al., 1958). However, this control was far from adequate for producing maximum crop yields, and was such that the use of an efficient insecticide for borer control seemed justified, even if at the expense of losing some natural enemies. The decision still appears to have been a good one.

There have been, and may still be, speculation that the current use of synthetic organic insecticides in the sugar cane area will in the long run aggravate current insect problems, and possibly cause minor pests to assume roles of major importance. Such speculation has been based upon one or both of the following assumptions: (1) Endrin would kill the natural enemies of the sugarcane borer and possibly those of other minor pests, with the result that the ravages of all would become more severe, unless increasing amounts of insecticides were used to control them. (2) The sugarcane borer would eventually become resistant to endrin, thereby leaving us in a worse condition than before, since by this time we would have destroyed the natural enemies of the borer.

It is possible that the continued use of highly effective insecticides on sugar cane may eventually reduce the natural enemies of insects which feed upon the crop to the extent that they will become more important in the absence of control measures against them than they are now. However, there is no indication to date that this has been the case. Surveys have shown that initial borer populations are lower the following year in fields previously treated with endrin than in untreated fields (Hensley *et al*., 1961). In all probability Louisiana growers could better afford to control several major pests of sugar cane with chemicals than to accept the annual losses which have been inflicted by the sugarcane borer when an effective insecticide was needed but not used.

The sugarcane borer most likely will become resistant to endrin sooner or later. However, the same forces which may act to bring about resistance in sugarcane borer populations are just as likely to cause insecticide-resistant populations of the borer's natural enemies.

A good field study of the effects of endrin on fish and other aquatic organisms in streams of southern Louisiana was conducted in 1961 by the Public Health Service with cooperation from the Louisiana State University Entomology Department. Results from this study have not yet been evaluated, but will be of interest to many people because of fish kills reported to result from the use of endrin on sugar cane. They will be of further interest because of the extremely sensitive analytical methods employed in water analyses which can now detect several parts per trillion of insecticides in water, i. e. quantities even less than those required to kill fish.

Endrin certainly has killed some fish in Louisiana and will continue to do so as long as it is used near streams. It is by far the most toxic to fish of all the insecticides in common use today. It can be calculated from data obtained by Henderson et al. (1960) that only 1/4 pound of 2% endrin granules would be needed to kill fish in one acre of water 3 feet deep; that means only 0.005 pound of actual endrin. According to Chin (1960) endrin has replaced rotenone as a fish poison in some areas in the Orient because of its lower cost and efficiency. Japanese workers have reported that paddy fields treated with 1/4 pound of endrin per acre retained some residual toxicity to fish for approximately one month, and that water over 100 meters from the treated fields also killed fish (Iyatomi et al. , 1958). Endrin has also been found to be the most toxic of several insecticides tested against shrimp (Chin, 1960).

Past research has shown that chlorinated hydrocarbon insecticides move downward very little in soils even when leached daily with water (Ginsburg and Reed, 1954; Lichtenstein, 1958). However, Tarzwell and Henderson (1957) treated a 6-acre grassy slope with 50 pounds per acre of a granular dieldrin-attapulgus clay formulation, which represented an application of 4.66 pounds of dieldrin per acre. Runoff water from the first rain following treatment was toxic to fish at a dilution of one in 3, and a few fish showed characteristic physiological reactions when placed in runoff from the fourth rain. Endrin has been reported to be from approximately 10 to 20 times more toxic to fish than dieldrin (Henderson et al., 1960).

It is not difficult to imagine that heavy rains, of the type sometimes encountered in southern Louisiana during the borer control season, might wash from fields into streams sufficient poison to kill fish. Small amounts of endrin, applied directly to streams through careless flying or leaking hoppers, can also cause unnecessary fish kills.

Besides fish, other wild animals likely have been killed by endrin. Occasionally I have seen dead snakes, rats, mice and birds in treated fields or along field margins where endrin was used. I have heard a similar reliable report concerning rabbits. However, no field studies have been conducted which permit an overall estimate of the amount of damage that has occurred to wildlife following the use of endrin on sugar cane in Louisiana.

Laboratory experiments indicate that prolonged exposure to various insecticides, including endrin, could result in depletion of wildlife resources, either through direct mortality of breeding stock, or through impairment of reproduction (De Witt, 1958). Feeding of diets containing 100 ppm of DDT to quail had little effect on numbers of eggs produced or chicks hatched. However, less than 10% of the chicks from these birds reached maturity, while more than 80% of the chicks from normal parents survived under identical conditions on insecticide-free diet. Endrin was found to be 200 times more toxic to young quail than DDT.

It seems appropriate to mention at this point that caged animals may not always respond to insecticides as they would in the wild. Von Horn (1958) writes that caged animals frequently will feed on treated materials which the same animals in the wild state would avoid. In meadows which had been treated with endrin to control field mice, he observed with binoculars that wild rabbits altered their path ways to avoid the treated areas.

The so-called "balance of nature" is a term to which more importance sometimes is attached than appears justified. Some staunch advocates of the maintenance of a"balance of nature" or a status quo in nature seemingly forget that the "balance of nature" was disturbed when the first trees were cut to make room for crops. The growth of new subdivisions and of our highway system continues to upset the balance of nature annually.

Nature is for man's enjoyment. Therefore we should treat nature as the majority of our people desire. However, we must strive to keep this majority as well informed as possible in order that their decisions may truly be in their own best interests. I believe that good control of the sugarcane borer at the expense of some fish kills and wildlife losses serves the best interests of the majority of the people in south central Louisiana.

The adverse effects on fish and wildlife which have reportedly resulted from the use of endrin probably would be much reduced if growers would use the insecticide only when and where potentially injurious borer infestations are already present. Insurance applications should be avoided. The insecticide should be applied to sugar cane fields, but not scattered heedlessly over woods or bodies of water.

Resistance to Insecticides

Preliminary laboratory tests conducted at Louisiana State University during 1961 have not indicated any appreciable resistance to endrin in sugarcane borer populations. These have included a comparison of borers from Youngsville, Louisiana, where endrin has never been used commercially, with another population from Port Allen, Louisiana, where the insecticide has been used regularly since 1958. However, this gives us no reason to suspect that this insect will not become resistant. It has been found that "insecticide pressure" may be applied against insect populations through many generations with little increase in resistance, followed by a period of rapid increase which leads in a few more generations to a limit characteristic of the chemical, the method of selection, and the population (Hoskins and Gordon, 1956).

Resistence is brought about by the survival and reproduction of a small proportion of the population which was in some way peculiarly adapted to survive treatment with a certain insecticide. It has become so common among insects that it should be anticipated wherever larger scale control programs are characterized by the repeated use of a highly effective insecticide over a period of many generations.

The rate of increase in resistance ordinarily depends on the amount of heritable variation in the insect population and the intensity of selection, i.e. the intensity of insecticide control measures applied (Crow, 1957). The use of endrin to control first generation borers or any insignificant infestation constitutes unnecessary selection for resistance. Generally the greater the proportion or each generation killed, the more rapid is the increase in resistance. This may not be true when the number of survivors becomes so small that the population loses too much of its genetic variability.

The term "cross-resistance" has arisen in recent years because of the finding that resistance to some insecticides automatically confers a degree of resistance to some others also. Brown (1960) enumerates 6 types of insecticide resistance among which DDT-, dieldrin-, and organophosphorus-resistance are the most important. Dieldrin resistance is believed to include such closely related compounds as chlordane, heptachlor, aldrin and endrin. For this reason when resistance has occurred it has frequently been necessary to change to an insecticide of an entirely different type which acts on the insect in a different way. This is one reason that we have been so interested in developing substitutes for endrin such as the organophosphate, guthion, and the carbamate, sevin.

One proposed solution to the resistance problem has been the alternate use of 2 entirely different types of insecticides. This approach assumes, in part, that insects which have developed some resistance to one insecticide will be more susceptible to another (Gordon, 1961). Thus, by alternating endrin with another insecticide from year to year, insecticide resistance in the sugarcane borer might be delayed greatly or indefinitely postponed. The chances for success of such a program probably would depend partly upon the number of growers participating in it and the size of the area involved. Of course the mere recommendation of such a program by research workers could not be expected to insure its proper conduct.

The feasibility of this solution to the resistance problem is supported by recent findings on control of the European red mite on apple trees in Pennsylvania (Asquith, 1961). It was found that both Kelthane and Tedion, when used separately as the only acaricides for a period of 3 seasons, caused the development of strains of the mite resistant to each, respectively. However, when these chemicals were used alternately at standard concentration, or mixed together with each at one-half standard concentration on the same trees for 3 years, strains of the mite did not develop with enough resistance to impair the control obtained during the third year of use.

The mixing of unrelated chemicals as control agents presents another possible solution to the resistance problem. The reasoning behind this approach is based on the genetic premise that selection for multiple characters is usually a slower process than selection for single characters (Asquith, 1961). This suggests that the sugarcane borer might find the process of becoming resistant to a combination of endrin with some other insecticide more difficult than acquiring resistance to either chemical alone.

The practices of mixing unrelated chemicals and of the alternating use of two different chemicals might be compared experimentally in 2 sizeable and relatively isolated sugar cane areas over a period of several years. If resistance should fail to become a problem in either or both of these areas while becoming a critical problem in the main cane area, an alternative control method with better chance for continuous effectiveness might be immediately available. Such an undertaking would not be practicable without the enthusiastic cooperation of all growers in the study areas.

Conclusion

The best immediate solution to all of the problems created by the use of insecticides on sugar cane in Louisiana would be for all growers to use these chemicals only when a potentially injurious insect population is present. Do not use insecticides as insurance against crop losses.

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COURSE OUTLINE

SUGAR CANE PRODUCTION[1]

by
Russ Miller
Department of Agronomy
Louisiana State University

This course is taught as Agronomy 108 to juniors, seniors and in some cases, to graduate students who take this course among others numbered 100 and above in their graduate program. It is offered in the fall semester only. Two hours of lecture and two hours of laboratory each week. The lecture is given at eight a.m. on Tuesday and Thursday and the laboratory from three to five p.m. on Wednesday.

The topics and sub-topics discussed in the lecture are as follows:

I. Origin and early history

    A. Origin

        1. China   2. India   3. Melanesia

    B. History of culture

        1. From II Century B.C. to 650 A.D.

    C. Trek of migration of sugar cane from origin to Louisiana in 1751.

II. Development of the sugar cane industry in Louisiana.

    A. Attempts to establish the sugar cane Industry

        1. Dubrevil   2. Mendez and Solis

    B. Commercial manufacture of sugar in Louisiana.

        1. Etienne Debore

    C. Causes of fluctuations in sugar production in Louisiana

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[1] Agronomy 108. A study of sugar cane and its production.

III. Classification of Sugar Cane

A. Species

B. Description (morphological)

1. Roots 2. Stems 3. Leaves 4. Flowers

IV. Sugar Cane Improvement

A. Mode of reproduction

B. Flowering

C. Fertility (pollen viability)

D. Chromosome number and behavior

E. Breeding methods

F. Seed production

G. Seedling production

H. Development, testing and release of a new variety

V. Climate and Soils for Sugar Cane

A. Climate

B. Sugar cane soils of the world

C. Soils of the three sugar cane districts in Louisiana

VI. Drainage and Land Preparation

A. Drainage

1. Surface 2. Open ditch 3. Underground

4. Features of a good drainage system

B. Land preparation

1. Discing 2. Harrowing 3. Rotations

4. Cut crowning (turtle -backing)

VII. Planting and Cultural Practices

A. Planting

1. Method 2. Time 3. Rate 4. Covering

VII. (continued) Planting and Cultural Practices

- B. Shaving and off-barring
- C. Hilling up (earthing up)
- D. Germination, tillering and growth

VIII. Varieties

- A. Old varieties
- B. New varieties
- C. Recommended varieties according to heavy and light soils and districts.

IX. Sugar Cane Fertilization

- A. Yield response on light and heavy soils with nitrogen, phosphate and potash
- B. Fertilizer recommendations for different soils

X. Weed Control

- A. Cultural
- B. Chemical
    - 1. Materials 2. Rate 3. Time 4. Method

XI. Diseases and Insects

- A. Diseases
    - 1. Major diseases in Louisiana. a. Selection of diseases free planting material. b. Rogueing c. Seed treatment
- B. Insects
    - 1. Kind 2. Control
        - a. cultural
        - b. biological
        - c. chemical (time, rate, method)

The laboratory work in this course consists mainly of field trips. The students are required to make a written report on each trip and this material is turned in at the end of the semester. Each student is required to write a term paper on an important subject in sugar cane production. This paper is presented orally to the class at the closing of the semester.

Field trips taken and topics discussed during regular laboratory hours are:

1. L.S.U. Sugar Cane Experiment Station
    a. Drainage layout
    b. Soils
    c. Variety selection and inspection
    d. Plot planting
2. Katherine Plantation
    a. Seedbed preparation
    b. Seed treatment
    c. Planting
3. Cinclare Plantation
    a. Planting
    b. Chemical weed control
    c. Harvesting
4. L.S.U. Photoperiod Houses
    a. Flowering
    b. Seed production
5. Greenhouses
    a. Seedling production
    b. Mosaic inoculation
6. L.S.U. Sugar Mill

A two-day trip is taken through the entire sugar belt of Louisiana. On this trip we visit the following:

7. Outfield Test Plots in the Northern, Southwestern and Southeastern districts.

8. U.S.D.A. Sugar Cane Field Station at Houma, Louisiana.

9. Thompson Machinery Company at Thibodaux, Louisiana.

The countries and states represented by students in this course over a ten year period, 1952 - 1961, are shown in the following table.

Countries and States Represented by Students in Agronomy 108,
"Sugar Cane Production"

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	
Belgian Congo		1									1
Bolivia				1							1
Brazil	4		1			2	1				8
Burma	1				1		1				3
Colombia	1		1	3	1						6
Costa Rica								1			1
Cuba		1	1				1	5	1	2	11
Dominican Republic										1	1
Egypt				1			1		1	4	7
El Salvador		1			1						2
Hawaii				1	1						2
Honduras								1			1
India	1	2	1			2		2		1	9
Iraq										1	1
Louisiana	3	4	8	9	6	7	2	5	4	4	52
Maine				1							1
Mexico	2							1			3
Natal									1		1
Nicaragua			1		1						2
Okinawa			1				1				2
Pakistan				1							1
Panama		1		2							3
Peru	1			1		1					3
Philippine Islands		1									1
Puerto Rico		1	1			1	1	1			5
Taiwan			1				1	1			3
Thailand			1	1							2
Venezuela		1		2							3
TOTALS	13	13	17	23	11	13	9	17	7	13	136

BAGASSE BURNING IN MULTI-CELLS

Irving E. Legendre, Jr.
Lafourche Sugar Company

Two Bigelow boilers equipped with Detrick-Dennis Multi-cell furnaces burned 76% of our bagasse production for the 1961 crop. One boiler has 13,250 square feet of heating surface or 1325 Hp capable of producing 100,000 pounds of steam per hour, and the other Bigelow has 15,000 square feet of heating surface or 1500 Hp with a rating of 120,000 pounds of steam per hour, both under continuous load.

The Bigelow boilers are both type F three drum design water tube boilers with a designed operating pressure of 250 pounds per square inch. The only differences between the boilers are the centerline distance from the steam to the mud drums, and the length of the drums.

The 1325 Hp boiler, installed in 1959 with Abco settings, was designed to burn straight gas. This past year the boiler was raised, walls included, 17½ feet to accommodate the four 6 foot diameter Detrick-Dennis cells in order to burn bagasse.

Enclosing each individual cell is a steel tank of 10 gage material which measures 8 feet in diameter by 12 feet high. This tank serves as the air enclosure between the duct from the forced draft fan and openings in the brickwork of the cell for the burning of bagasse.

Each of the four cells is equipped with an air operated dumping hearth and ash pit. The height from ground level to the dumping hearth is four feet. In case of a failure in the dumping mechanism, the cells may be cleaned through a large access door located just above the level of the dumping hearth.

The bagasse is introduced into the cells through openings in the side furnace walls and allowed to fall by gravity into the center of the cell. Air if forced into the cell through openings in the brickwork around the circumference of the cell to a height of about three feet above the base of the cell.

There are two rows of tangential openings, one being four feet up and the other row nine feet up. The cone of bagasse is maintained to the height of the peep hole which is five feet above the base of the cell.

The cells of the 1500 Hp boiler are 6 feet 6 inches in diameter and the tank enclosures are 8 feet 6 inches in diameter. All other dimensions of these cells are the same as the 1325 Hp Bigelow.

Both boilers have identical forced draft and induced draft fans. Each has its own self supporting stack.

The two boilers have complete automatic and manual controls which were furnished by the Republic Flow Meter Company. Three 20 inch Fan-Mix gas burners have been installed in each of the two boilers.

When clean, well burnt cane was delivered to the mill the two boilers were able to supply all of the steam requirements for the factory by burning 85% of the bagasse production on 4500 tons of cane. The two boilers consistently were able to burn around 95,000 pounds of bagasse per hour with peaks over 100,000 pounds per hour. Steam production at this time on the 1325 Hp boiler averaged 93,000 pounds of steam per hour or 210% rating, and the 1500 Hp averaged 110,000 pounds of steam per hour or 215% rating.

When grinding cane after a rainy spell the factory rate was reduced to about 3800 tons per day and the pounds of bagasse burnt per hour in the two boilers to 80,000 pounds. We would maintain practically the same steam production from the two boilers with gas as a supplemental fuel. On each boiler the steam flow rate could be set automatically. If by burning bagasse alone the steam output fell below the desired set point for any reason, for instance the mill stopping, the gas burners would automatically cut in to produce steam until the flow coincided with the set point.

The ratio of total heating surface to steam capacity on the 1325 and 1500 Hp boilers furnished 7.5 to 8 pounds of steam per square foot of heating surface per hour.

Each cell was cleaned once every twelve hours when clean cane was delivered to the mill and on an average 3 to 4 wheelbarrows of ashes were removed from each cell during this cleanout. However when shucky, muddy cane was processed each cell was cleaned once every eight hours and from 10 to 12 wheelbarrows of material were removed per cell. The cleanout time per cell during both operating conditions was the same. It took an average of fifteen minutes from the time the feed gate was closed, allowing the bagasse to burn down, dump the ashes, re-light the cell, and return the cell to its operating burning rate. During the time of cleanout the steam production would fall off about 20%.

In burning clean cane the ashes and slag would form a porous crust over the top of the grate and at times would remain caught between the opening of the grates. In this case the access door would have to be opened and with the grate still in the open position the material had to be forced into the ash pit.

When burning cane immediately following a rain the dumping of ashes was quite fast and left the grates clean because most of the material was dirt and it easily fell through the grate.

The practice in the boiler room was that when the whistle sounded at the mill signifying that it had stopped, was to immediately close off the forced draft fan. This allowed time for the bagasse to bank within each cell for it took about three minutes to empty all the carriers of bagasse from the mill to the cells. The induced draft fan provided enough draft to allow the bagasse to burn slowly. If the mill stop was no longer than a half hour there was enough bagasse in the cells to permit instant lightup when the mill would resume grinding. For longer stops bales of dried bagasse one year in age were used to maintain the fire in the cells. When the mill would begin to grind again the forced draft fans were started and in a matter of less than two minutes after bagasse started dropping into the cells the steam production was back to normal level.

Our crew in the boiler room consisted as follows: one head water tender and assistant, one bagasse fireman and two helpers, making a total of five men per shift.

BURNING BAGASSE IN STOKER FURNACE

Patrick Cancienne
Lula Factory

Type of Furnace - Union Iron Works Type VO Steam Generating Unit with Water Walls and steel casing. Has 11,081 square feet heating surface.

Furnace - Riley Spreader Stoker with over fire air system, phenematic spreader and Riley chain type feeder. Furnace volume of 4,500 cubic feet.

Steam Generating Capacity on:

a) Bagasse - 70,000 lbs. steam per hour (2030Hp or 200% rating)

Quantity of fuel - 15 tons bagasse @ 52% moisture per hour.

b) Natural gas 91,000 lbs. steam per hour (2640 Hp or 240% rating)

Ration of steam output to heating surface 70,000 lbs. steam generated per square foot of heating surface on bagasse.

Cleaning:

a) Clean four times every 24 hours.

b) It will take about 60 minutes to clean boilers for each clean out period.

c) Steam capacity during cleaning drops from 70,000 to 60,000 lbs. of steam per hour or about 15 percent in capacity.

d) Total steam capacity less during the whole days operation is 40,000 lbs. Boiler rated at 70,000 lbs. of steam per hour or 1,680,000 of steam per 24 hours. Total loss in capacity from cleaning is about 2½ percent of capacity.

e) We removed an average of 10 wheelbarrows from the boiler every six hours.

f) The ashes removed were very loose. About like a mixture of sand and dust in appearance. We did not find any clinkers.

Burning bagasse from dirty cane involved more work for the operator. The steam generator dropped about 15 per cent on an average. Ashes removed increased about 40 per cent with the physical qualities about the same. By clean cane I am speaking of cane with 3 to 4 per cent trash. Dirty cane is this comparison has from 14 to 16 per cent trash.

With a mill stop this boiler is fired on natural gas. If the stop is of a period lasting over an hour the boiler operator would dump the grates and clean out the boiler at this time. After the mill started the operator would have this boiler generating steam from bagasse within 5 minutes. On each side wall near the grates we had small burners installed to light the bagasse. This worked very well. We washed the cane continuously on our feed tables.

PRESENT DAY MILLING PRACTICE AT GLENWOOD

by
Luis Suarez

Due to the conditions of the cane ground and the high grinding rate of the sugar mills in the state, mill grooving is most important.

Most of us that had experience with clean cane in the past, had to learn all over again with these new conditions. Not only with changes in variety of stubble and plant cane, but also and more important, the mud and trash made a surprising accumulation of grinding problems never experienced before.

The first thing that surprised me is the roll wear in the mills. It varies with the amount of load in the mills, trash, mud in the cane, pressure applied and grinding speed.

A shell with small grooving by the middle of the crop is in bad shape. Worn rolls makes feeding of the mill very difficult. The only way it can be helped is by lowering the pressure with a consequence drop in extraction. You know from experience that 3/4 of an inch wear on top roll is about an average for 175,000 ton crop with the type of cane we grind in Louisiana. At Glenwood we have had over one inch wear in one crop.

In the countries where a mill grinds only clean cane the wear will be about 1/4" for a normal year.

Our first change at Glenwood was to go to a larger pitch and greater angle. We tried 1 1/2" pitch with 50° angle but were not satisfied with the drainage. Next we tried a 2" pitch with a 45° angle on our first mill and 1 1/2" pitch with a 45° angle on our second, third, fourth and fifth mills. The last change was better, except for the breakage of the teeth on the top and back rolls. After the 1960 crop we found out that the damage was severe.

We had a considerable amount of repair to damaged teeth on the rolls.

For our 1961 crop we tried differential grooving in three of our mills. This seems like the ideal solution to the problem. The top and back rollers were grooved with a 50° angle and the front roller with a 45° angle. This gives the drainage required in the front roll and a stronger tooth for the top and back rollers.

Under good conditions we carried at Glenwood in our back mills from 60 to 70 tons per linear foot with 25% maceration. It was found out this year that with the differential grooving under very bad conditions of mud and trash that we were able to keep our pressure high in our last mill, but in our fourth mill, without differential grooving we had to lower it to 58 tons per linear foot. Although we changed the ratios and speed during the crop, the fact remained that we were able to carry more pressure in the last mill regardless of the setting used. I am sorry to say that I have no technical explanation for this advantage, except to point out, that with differential grooving the pressure per square inch is less in the front roll than in the top and back roll. The difference in the angle of the top roller and the front roller and the pressure per square inch are the only variables that we had this year in the fifth mill. Last year it was a new shell and we had a great deal of difficulty with the mill taking cane. It was necessary to apply electric welding to avoid slippage of the mill. This year, the second for the shell, with differential grooving, pressure was never lowered and operation of the mill was ideal all through the crop.

Many sugar mills in Cuba had differential grooving claiming that it was an ideal grooving for the mills although I have never read a technical explanation for this claim.

Again I state, that the reason for using at Glenwood, a differential grooving was to have drainage in the front roller and stronger teeth in the top and back roller and it does seem that as pointed out above the advantage is greater than expected.

For those who are interested in using differential grooving and would like an easy way to figure the area you will find a deduction of the formula with a corresponding sketch, in the last page of this paper.

SILVER CONTINUOUS CENTRIFUGAL

by

Clarence R. Steele

Early in my training as an engineer, I was advised that the proper evolution of a design was always toward simplicity, but this usually after the design had passed through a stage of complexity. Galileo in the 16th Century pointed out that nature follows the custom and practice of accomplishing its purposes in ways that are common, simple, and easy. Newton said that nature is pleased with simplicity. I am sure that each of you know of many designs that in the past have been very complicated but have become simple. Probably the most notable at this time is the development from the piston type aircraft engine to the jet.

It is almost axiomatic that this evolution from complexity to simplicity brings with it greater efficiency, such as better performance, lower costs, greater reliability, better control, etc.

The continuous centrifugal for sugar is such a development. This machine also has the advantage of extreme simplicity. Mechanically, it consists of one rotating spindle mounted on two anti-friction bearings driven by V-belts from a vertical constant speed electric motor. In addition to this mechanical simplicity, it also has the advantage of being subject to automatic control with the resultant continuity of performance. Another advantage is the low horsepower requirement. The machine runs continuously without accelerating loads, and can thus be driven with a standard 25 HP squirrel-cage motor.

We obtained the American rights to this machine a few years ago from Hein, Lehmann & Co. of Dusseldorf. They had done considerable pioneering work in Germany. We found that American practice required more exacting performance and higher efficiency. As a result of many tests, we were able to redesign the German machine to give better separation and a considerably higher capacity. The photograph in FIGURE 1 shows an installation of these improved machines.

Our office and plant is in Denver, Colorado, and so this development work was logically done in beet sugar factories. We have, however, been most interested in cane factories, and as soon as our design had been proved, we contacted Dr. Keller, asking his assistance in obtaining an opportunity to demonstrate this machine in Louisiana.

Arrangements were made with Valentine Sugars, Inc. for them to install and test a machine. These arrangements were completed late in the season after all of our available centrifugals had been committed, so it was necessary to borrow a machine that was going to Puerto Rico. This machine was installed by Valentine in time to get 22 days' testing before it had to be removed for reshipment.

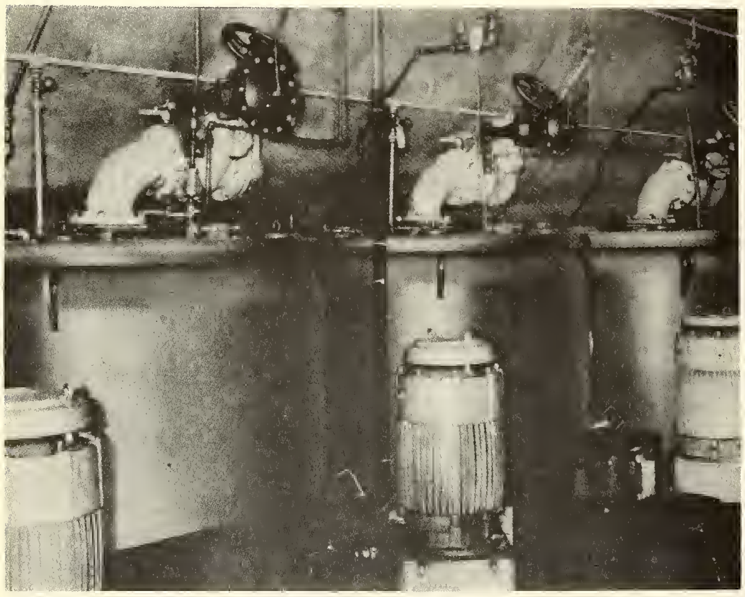


FIGURE 1--Continuous centrifugal installation

FIGURE 2 shows a cross section through this continuous centrifugal. You will note the rotating conical screen type basket mounted on top of a simple spindle.

This assembly is driven at 2200 RPM by a set of V-belts from a vertical motor. The basket is surrounded by collecting chambers for the syrup and the sugar. The massecuite flows through the feed pipe into the center of the cone, or the point of zero velocity. Within the smooth center cup, the massecuite is accelerated to the velocity of the basket very smoothly and gently so that the crystals are not ground or broken. Any damage to the crystals at this point would result in small pieces that could escape into the syrup.

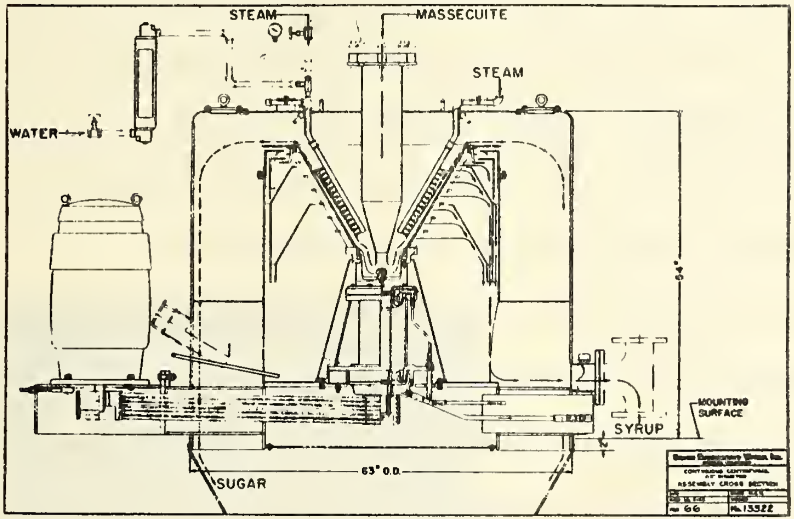


FIGURE 2--Cross section through centrifugal

From the accelerator bowl, the massecuite flows upward and outward over the conical surface. This surface is covered with a very fine screen that permits the escape of the syrup while retaining the sugar crystals. The centrifugal force increases as the sugar moves up the slope, gradually draining the syrup film from the crystals. The basket speed of 2200 RPM gives a maximum centrifugal force of 2000 G's.

Spraying steam in the basket helps in cleaning the sugar by reducing the viscosity of the syrup. Superheated wash water may also be sprayed over the sugar as it moves up the basket.

The syrup is thrown outward through the basket walls and is collected in an annular space. From there it drains downward to a discharge pipe near the bottom of the machine.

As the cleaned sugar passes the top rim of the basket, it is discharged outward into a second annular space outside of the syrup compartment. The sugar then drops downward from the bottom of the machine.

The feed of massecuite is automatically controlled at a rate that gives the optimum sugar quality. This control senses the motor load and adjusts a butterfly valve in the massecuite line to maintain the load at the selected value.

The spindle is mounted on two bearings, a ball bearing at the bottom and a roller bearing at the top. These are lubricated by pumping with a motor driven pump a small quantity of oil above the top bearing and allowing this oil to drip downward through both bearings, then returning this oil to a reservoir for cooling before recirculating. The construction of the bearing housing is such that during operation the oil passes freely through the bearings, but, when the machine is stopped, the oil collects around the bearings so that they are completely submerged. This arrangement gives adequate lubrication while running and protects the bearings from corrosion during the idle season. The pump motor is interlocked so that failure shuts down the main motor. A visual indicator on the side of the machine shows when oil is flowing.

The bearings, sheaves, and V-belts are the only parts subject to wear. All wetted surfaces of structure are stainless steel to prevent corrosion or erosion. The stainless steel screen lining the basket is subject to some wear from the sliding of the sugar crystals. Indications are that the normal life expectancy of this screen is 60 to 100 days. It is, however, subject to mechanical damage if foreign objects are allowed in the massecuite stream.

The photographs of FIGURES 3 to 6 show the installation at Valentine Sugars, Inc. You will note how easily the machine can be installed. Here it was set at one side of the batch machines on a simple steel structure. There is one water jacketed pipe to bring the massecuite over, another pipe to take the syrup back, and a short scroll conveyor to return the sugar.

Figure 5 shows the control panel. The massecuite load is set with the knob in the center of the panel. The setting is shown on the large center dial. The controller then automatically adjusts the control volve shown in Figure 6 to maintain the massecuite load. Figure 6 also shows the manually set regulator that maintains a constant flow of wash water. Once these controls are adjusted, no further attention is required except an occasional checking, probably at the beginning of each strike. Thus, no operator is required, since this checking can easily be done by the supervisor. It is, of course, desirable that the machine be washed out thoroughly periodically.

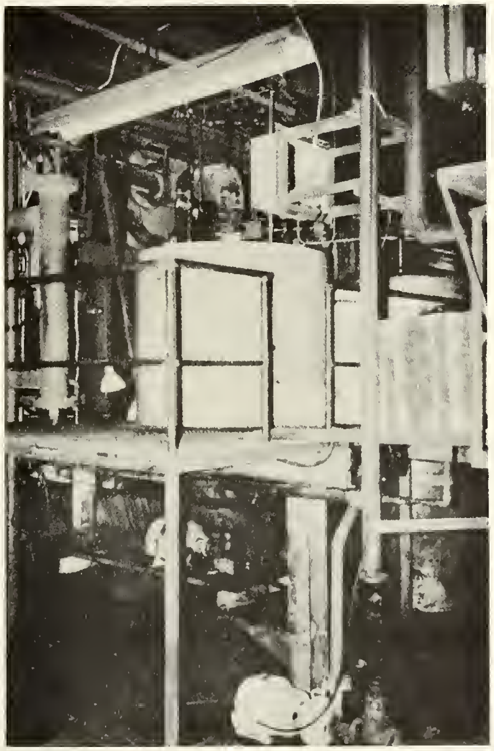


FIGURE 3--General view installation at Valentine factory

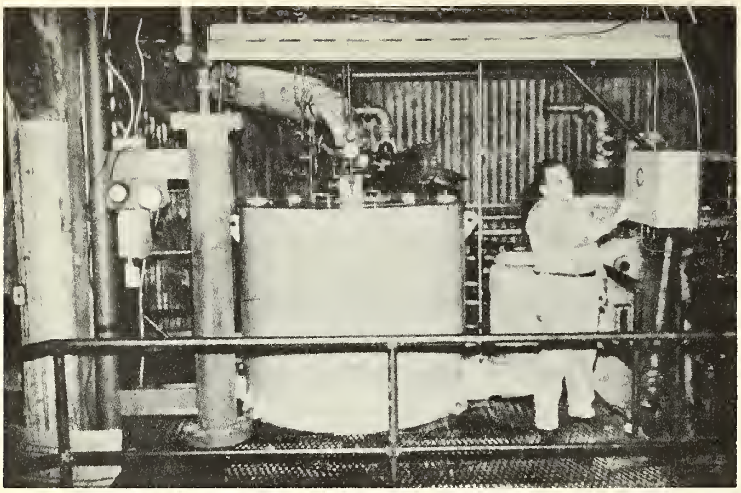


FIGURE 4--Continuous centrifugal at Valentine factory

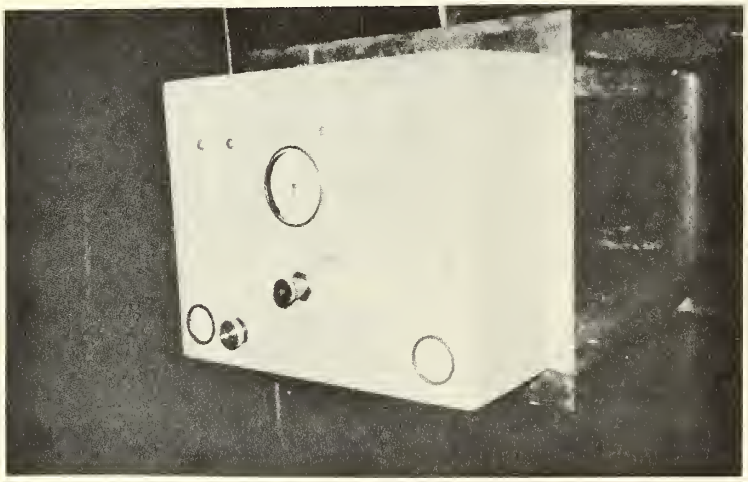


FIGURE 5--Control panel at Valentine installation

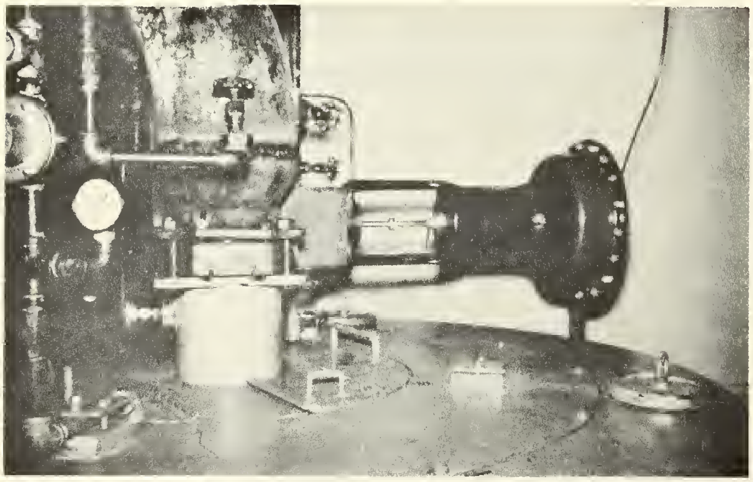


FIGURE 6--Valentine installation view showing massecuite line and control valves

FIGURE 7 shows a view down into the fully loaded, spinning basket. You can see the stream of massecuite leaving the feed nozzle and the manner in which it is brought up to speed in the accelerator bowl. Note the uniform distribution over the basket walls. Note also the water and steam sprays.

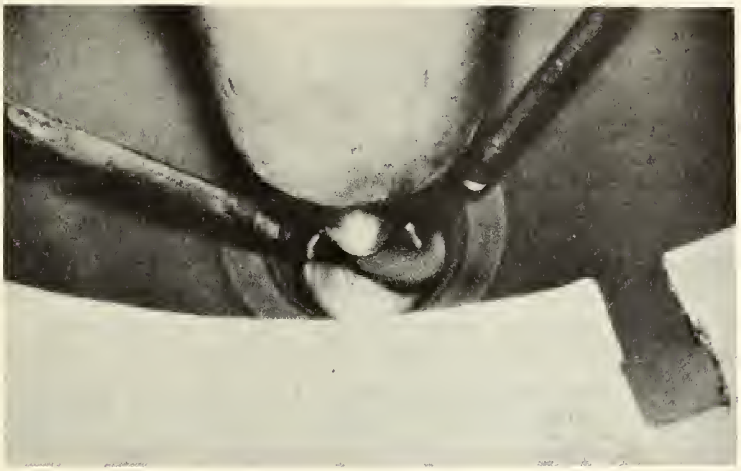


FIGURE 7--Inside of fully loaded, spinning basket

There is a sample cup into the sugar compartment at the side of the machine to catch samples of the cleaned sugar. FIGURE 8 shows such a sample.

The continuous centrifugal was operated by Valentine Sugars, Inc. for 22 days. Many samples of sugar and molasses were taken. CHART NO. 1 gives the averages of all of these samples with comparative values for the batch machines.

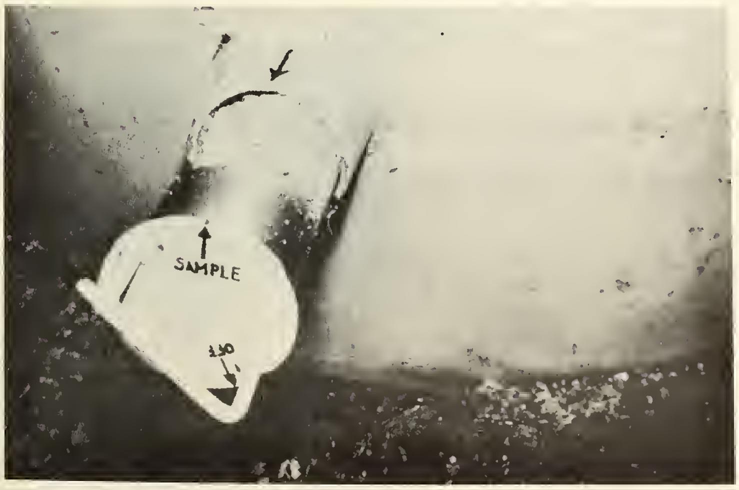


FIGURE 8--Sugar sample as caught in sample cup

CENTRIFUGAL PERFORMANCE

AVERAGE OF ALL TESTS FOR 22 DAYS

	C—SUGAR		MOLASSES		THROUGHPUT
	POL	COLOR	PURITY	BRIX	CU. FT. MASS/HR.
CONTINUOUS	90.55	101	36.15	93.13	121
BATCH	89.16	118	36.22	91.13	45

MASSECUITE		
PURITY	BRIX	TEMP.
62.64	96.95	128° F

CHART NO. 1

The continuous centrifugal molasses samples were taken from the line leaving the machine. The sugar was caught in the sample cup. With continuous flows, these samples are representative. The batch molasses figures are the regular factory laboratory figures for the same period of operation. The batch sugar samples were taken from the batch machines before plowing. Three tubular samples were cut from the wall of sugar; one from the top, one from the center, and one from the bottom. The massecuite figures are the regular factory samples.

This was a test and demonstrative operation. Such an operation covers work over as wide a range of conditions as possible. Some of the conditions set up are good and some are not. Chart No. 1 gives the averages of all of this work.

There was a period of four days during which the conditions were held at normal commercial operational values. The results of this period are shown on CHART NO. 2 with comparative data from the batch machines for the same period.

CENTRIFUGAL PERFORMANCE

AVERAGE OF 4 DAYS COMMERCIAL OPERATION

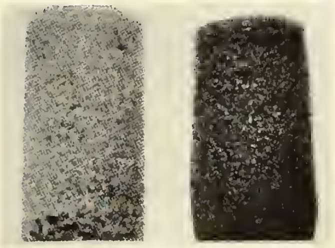
	C—SUGAR		MOLASSES		THROUGHPUT
	POL	COLOR	PURITY	BRIX	CU. FT. MASS./HR.
CONTINUOUS	91.20	106.5	35.95	92.28	142
BATCH	86.19	153.5	36.19	92.34	45

MASSECUITE		
PURITY	BRIX	TEMP.
62.82	96.89	131.5°F

CHART NO. 2

This continuous centrifugal is a different method of spinning sugar. It has many characteristics that are different from batch machines. One of these is its ability to handle poor strikes or strikes with mixed grain. The sugar moves up the basket in a very thin layer. Small crystals do not have the opportunity to block the flow of syrup like they do in a batch machine. The results of spinning such a strike are shown on CHART NO. 3.

Another different characteristic is the action of wash water. This also is due to the fact that the layer of sugar on the basket is extremely thin. Wash water can be applied so that a crystal moves under the spray, has its molasses washed off, then moves on before any sugar is melted. Each crystal is treated directly under the water spray. It is not necessary for the water to move through four or five inches of sugar, becoming saturated with melted sugar, in order to treat all of the crystals.



CONTINUOUS BATCH

	CONTINUOUS	BATCH
SUGAR		
POL	93.8	79.2
COLOR	60	230
MOLASSES		
PURITY	39.19	38.98
BRIX	92.62	93.82

MASSECUITE	
BRIX	96.14
PURITY	60.0
TEMP.	120 F

CHART NO. 3--Color and purity comparisons between continuous and batch machines on poor strike

The present thinking is that "C" sugar must not be washed because any washing melts sugar into the discard molasses. This is not true with our continuous machine. A small quantity of wash water can be applied to raise the sugar purity without raising the molasses purity. At Valentine Sugars, Inc., an average of 0.1 gallon per minute was used.

CHART NO. 4 shows the operating variables of the continuous centrifugal as wash water is applied and as the throughput is changed. These trends are applicable to the spinning of any sugar. You will note that as the quantity of wash is increased, the purity of the sugar rises very rapidly to a plateau, while the purity of the syrup rises very slowly. The left hand curve shows the effect of throughput on sugar purity. An understanding of these characteristics will enable the operator to set the machine so as to obtain the optimum values of sugar and syrup purities, while at the same time getting the maximum capacity.

CHART NO. 5 shows a typical horsepower curve for a batch centrifugal superimposed upon the horsepower curve for the continuous. This shows very graphically the power saving of the continuous centrifugal and points out one of the reasons for long trouble-free life, since it is not subjected to the frequent high accelerating and braking loads.

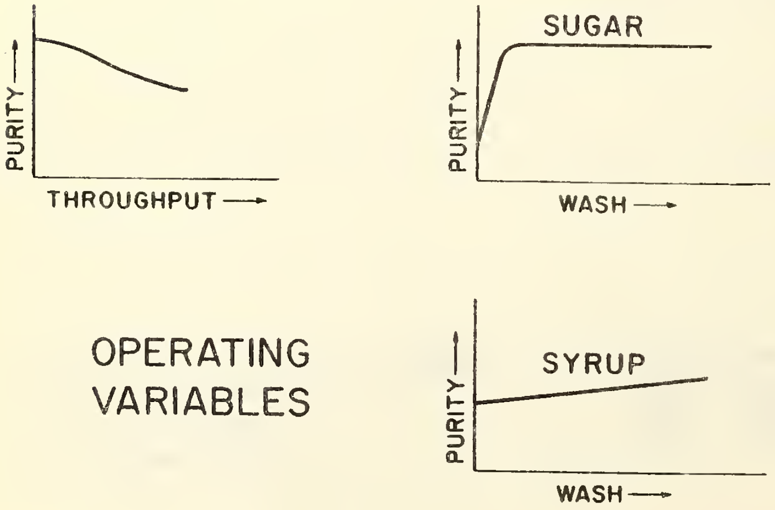


CHART NO. 4

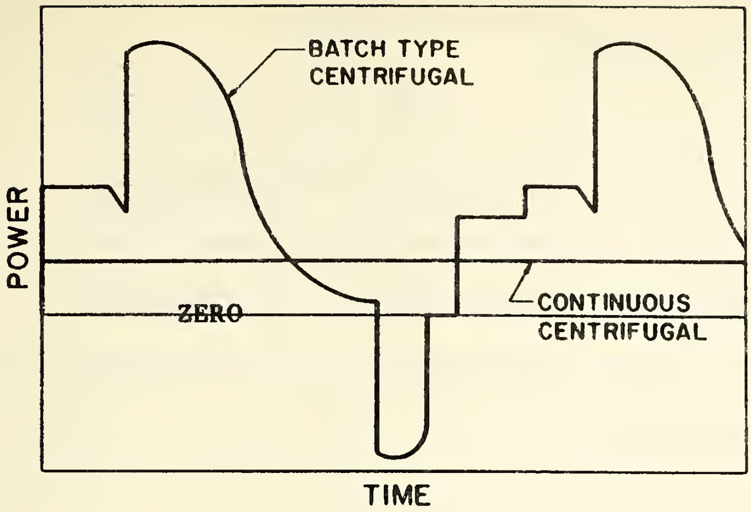


CHART NO. 5--Comparative power curves

This is a new method of spinning sugar. Its simplicity with resultant lower first cost and operating costs is obvious. It has demonstrated its ability to give equal or better results than batch machines with "C" sugar when used under exactly the same conditions. It can do the same for other sugars. Without a doubt, additional benefits can be obtained by adjusting boiling practices to take advantage of the improved sugar purities available and arranging massecuite handling facilities to properly prepare the massecuite for the continuous centrifugal.

EXPERIENCES WITH CONTINUOUS CENTRIFUGALS AT VALENTINE

by Hector Elizondo

SCORE OF TEST:

To determine possibilities of new Silver continuous centrifugal size 63 for drying "C" sugars in our factory. To determine actual capacity of this continuous machine under similar conditions in terms of our standard batch machines. To this purpose we obtained simultaneous data on our batch machines and the continuous to compare results.

CONCLUSIONS:

As we can see from the accompanying graphs of results, the quality of sugar and molasses are comparable. A bit higher purity in molasses of the continuous machine, but better color and polarization on sugar. This higher purities we see in the continuous machine may be due to little crystals being able to go through the screen because of its thin layer drying principle. In the batch machines some of these grains are caught in the thick sugar layer.

We tried to run this machine without water or steam, the same way we run our batch "C" sugar machines, but sometimes we found dust in the sugar, which disappeared as soon as we applied a very small amount of water or steam. Of course, they are different machines and we cannot expect exactly the same operation out of both.

The Silver continuous seems to be a more versatile machine, since you can change the quality of your sugars by making very little change in operation. I believe it would be an ideal machine to dry double purge massecuites in order to obtain a cleaner seed sugar for our footings in making turbinado sugar. Averages and maximum ranges during tests were as follows:

Sugar Pol	Continuous	84.10 to 95.70	Ave. 91.07
" "	Batch	79.20 to 93.20	Ave. 89.70
Sugar Color	Continuous	50.00 to 150.00	Ave. 96.36
" "	Batch	70.00 to 250.00	Ave. 115.50
Molasses Purity	Continuous	31.35 to 42.37	Ave. 37.18
Molasses Purity	Batch	32.10 to 41.81	Ave. 36.20

We can see very clearly that the continuous sugar is of better quality than batch sugar. But we can also notice a slight increase in purity in continuous molasses. Of course these results average the total of 61 tests analyzed. Capacity of Silver continuous can be said to be three times the capacity of one regular batch machine under our test conditions.

Most of our capacity tests were run on low load conditions and average capacity comes to be 121.39 cu. ft./hr., while batch machines were making 37.5 cu. ft./hr.

ADVANTAGES OF THE SILVER CONTINUOUS OVER THE BATCH MACHINES:

1. Does not need manual labor in its operation, and very little supervision. I believe one man can operate even 20 of these machines, to say a figure.
2. The capacity of one Silver continuous is better than three 24" x 40" batch machines.
3. Its cost is approximately the cost of a regular 24" x 40" batch machine.
4. The remarkable simplicity and reliability of its control equipment. Upkeep and maintenance can be made by a good mechanic.
5. Because of its principle of operation it rotates the sugar crystals in many positions avoiding the outside blind face where molasses may cling to the crystal.
6. The small amount of energy needed to operate this machine. 25 hp. did the work of three batch machines (40 hp. each).

7. The results of these tests show a superiority handling "C" massecuites, and it may be expected to do even better work drying "A" or "B" massecuites, since "C" massecuites are the hardest to dry due to their gummy nature.

DISADVANTAGES OF THE SILVER CONTINUOUS MACHINE:

1. A higher purity molasses. In our tests it showed 0.98 higher values as an average on 36 different "C" strikes.
2. The need of some water or steam for its satisfactory operation. In our tests it showed about 0.15 g.p.m. necessary to avoid sugar dusting, or the use of some steam (10 psi) in the gage.
3. The relatively high cost of screens. About $120.00 each. One screen is supposed to last one full crop.
4. During clean outs a special connection must be made to discharge washings-out of molasses troughs. The same must be done when washing sugar curb, since these sweet waters cannot be mixed with the dried sugars. Probably will have to be taken to syrup tanks when drying "A" and "B" sugars. Most probably, a mechanical device could be devised so as to clean mechanically sugar curb without the addition of water.

RESULTS OF TEST RUNS

	CONTINUOUS CENTRIFUGAL							Batch Centrifugal		
Test Run # and Date	Load Amps.	Wash Water g.p.m.	Steam to Wash Water	Steam Rinse	Sugar Color	Sugar Pol.	Molasses Purity	Sugar Color	Sugar Pol.	Molasses Purity
1-11/21/61	40	---	---	15	130	88.89	42.37	145	87.49	41.55
2-11/22/61	42	---	---	---	103	90.01	37.26	85	92.07	36.00
3-11/23/61	42	---	---	---	130	87.15	36.33	117	88.75	36.59
4-11/24/61	45	---	---	---	140	84.10	33.63	100	86.80	32.81
5-11/24/61	42	.25	0	0	110	88.55	33.19	133	86.15	32.25
6-11/25/61	44	.25	0	0	105	86.35	32.59	140	90.85	32.32
7-11/27/61	47	.25	0	0	115	90.15	36.08	100	91.75	36.85
8-11/27/61	48	.30	0	0	150	86.76	36.08	125	90.16	35.54
9-11/28/61	47	.30	0	0	85	91.75	36.24	95	90.65	35.01
10-11/29/61	50	.25	0	0	110	90.18	34.05	120	87.75	32.10
11-11/29/61	50	.25	10	0	105	92.15	37.33	160	86.95	33.83
				Average	116	88.73	35.92	120	89.03	34.48
12-11/30/61	45	.20	0	0	120	88.16	33.48	250	79.36	31.33
13-12/ 1/61	42	.10	0	0	125	88.81	34.41	120	89.61	34.41
14-12/ 2/61	45	.10	0	0	150	88.10	39.01	130	87.95	35.17
15-12/ 2/61	45	0	10	10	84	92.62	36.59	146	87.02	34.34
s1-12/ 3/61	43	0	1	1	---	89.70	35.34	---	90.20	35.17
s2-12/ 3/61	42	0	5	5	85	93.90	35.86	105	91.50	35.96
s3-12/ 3/61	41	0	10	10	85	93.00	36.70	135	90.81	36.12
16-12/ 3/61	48	.45	16	0	80	93.82	34.11	140	86.42	32.57
17-12/ 4/61	35	.30	10	0	80	95.70	38.12	135	86.80	34.82
				Average	89	92.58	36.45	145	87.74	34.43
18-12/ 4/61	37	.10	15	0	100	89.38	34.52	140	87.98	34.30
19-12/ 5/61	43	.20	12	0	125	88.95	35.48	110	90.15	34.63
s6-12/ 5/61	--	---	--	--	95	91.10	36.47	110	90.20	35.41
s7-12/ 5/61	41	.30	10	0	100	90.95	36.14	95	91.85	36.01
20-12/ 5/61	41	.30	10	0	---	-----	34.49	---	-----	34.66
21-12/ 5/61	40	.15	10	--	90	89.65	34.06	70	92.90	34.28
s8-12/ 6/61	39	.15	10	8	90	90.30	34.26	100	89.30	34.85
s9-12/ 6/61	39	.15	10	8	100	91.60	36.16	105	91.50	36.47
22-12/ 6/61	39	.10	8	8	95	91.18	31.35	92	92.18	34.38
s10-12/6/61	40	.10	8	12	85	91.10	35.04	95	90.90	34.96
23-12/ 7/61	41	.15	10	10	90	89.90	34.55	150	84.70	34.39
24-12/ 7/61	38	.15	10	5	115	89.38	35.79	120	88.78	34.71
s12-12/7/61	41	.10	5	5	65	93.10	36.95	90	91.60	36.16
s14-12/7/61	42	.10	5	5	100	89.40	36.93	120	88.90	35.14
25-12/ 8/61	40	.30	11	10	50	95.00	37.02	70	93.00	36.72
				Average	90	91.03	35.52	104	90.28	35.14

RESULTS OF TEST RUNS (Cont'd)

	CONTINUOUS CENTRIFUGAL							Batch Centrifugal		
Test Run # and Date	Load Amps.	Wash Water g.p.m.	Steam to Wash Water	Steam Rinse	Sugar Color	Sugar Pol.	Molasses Purity	Sugar Color	Sugar Pol.	Molasses Purity
26-12/ 8/61	50	.15	10	0	110	89.18	34.93	135	87.18	35.02
s15-12/8/61	42	.10	5	5	70	93.10	36.31	80	93.20	35.87
s16-12/8/61	50	.10	10	0	90	89.20	36.18	120	87.60	36.05
27-12/ 9/61	50	.15	8	5	60	93.80	39.19	230	79.20	38.98
s17-12/9/61	55	.10	10	5	105	90.20	36.16	160	84.40	36.24
s18-12/9/61	55	.15	10	5	80	90.90	39.79	140	88.20	37.64
28-12/10/61	55	.10	5	5	80	92.65	38.69	80	92.40	38.69
29-12/10/61	55	.15	10	0	100	90.35	41.67	94	92.75	41.81
s20-12/10/61	50	.10	5	5	100	91.90	39.48	105	91.70	37.45
s21-12/10/61	51	.10	5	5	95	92.50	40.61	100	91.60	39.69
s22-12/10/61	53	.05	5	0	80	92.20	39.89	110	91.50	40.15
30-12/11/61	50	.10	10	0	60	94.10	37.95	94	90.40	37.95
s23-12/11/61	54	0	5	5	90	91.80	41.31	95	91.40	40.13
s24-12/11/61	54	0	5	5	100	91.90	40.95	105	91.50	40.43
				Average	88	91.60	38.68	118	89.50	38.29
31-12/11/61	54	0	5	5	72	93.18	37.57	78	92.18	38.87
32-12/12/61	51	0	5	5	75	91.70	39.65	70	92.50	38.42
33-12/12/61	54	0	5	5	105	91.35	38.19	120	89.75	37.95
34-12/13/61	55	0	5	5	105	90.60	39.50	85	92.50	37.83
35-12/13/61	55	0	5	5	125	90.92	39.58	100	92.32	38.45
36-12/14/61	55	0	5	5	95	91.25	40.69	90	92.10	37.97
37-12/14/61	55	0	5	5	105	91.00	39.66	85	92.40	37.87
				Average	97.4	91.42	39.26	89.7	91.96	38.19
				GENERAL AVERAGES	96.32	91.07	37.18	115.50	89.70	36.20

RESULTS OF CAPACITY TESTS

Test Number	Duration Hrs. Mins.	Massecuite Dried Cu. Ft.	Screen	Load Setting on Machine	Strike #	Massecuite Brix	Massecuite Temp.	Massecuite Purity	Cu. Ft./Hr.	Tons/Hr.
1	2:25	227.59	.005X.005	40	58	94.50	125	63.49	94.23	5.546
2	1:10	165.59	.008X.008	47	83	98.56	127	63.72	141.93	6.803
3	1:58	174.00	.0026X.006	42	89	97.90	126	62.10	88.50	4.240
4	1:00	115.77	.005X.005	52	95	96.14	115	62.41	115.77	5.550
5	1:30	174.50	.008X.008	55	96	97.20	128	64.30	116.33	5.580
6	1:30	217.50	.008X.008	57	100	96.60	122	65.73	145.00	6.952
7	1:45	260.00	.008X.008	56	104	97.30	123	61.66	148.00	7.096

Average Capacity for these tests 121.39 Cu. Ft./Hr. or 5.967 Tons/hr.

THE BACH POLY-CELL SUBSIDER

by
Wilmer M. Grayson

The Bach Poly-Cell Subsider (Clarifier) was designed by Mr. Niels B. Bach after many years of experimenting with various types of clarifiers. Mr. Bach also designed the original Bach Subsider which is known all over the world for its simplicity of construction and operating efficiency.

It is a well-known fact that given an opportunity, fresh sugarcane juice, properly limed and heated, will settle fast and clear. Sometimes, during adverse weather conditions when sugarcane must be harvested from necessity, clarification is very difficult to achieve. Whenever a mud problem exists, there is a loss of capacity, loss of yield and poor quality sugar. The excessive trashy condition of the cane along with field mud causes money loss to the processor on every ton of cane he produced or buys. At this time especially, clear juice free of bagacillo would be of inestimable value to any mill. The Poly-Cell Subsider gives almost instant settling on whole juice, juice that will be in process just a short time, juice that is clear and sparkling and with little or no loss of sucrose and purity.

It is also a well-known fact, proved in any laboratory that properly treated juice will settle rapidly for the first five or ten minutes, seen by filling a glass cylinder with hot, properly limed juice. This settling rate is about an inch a minute for the first five minutes. After that the rate of settling is slow even if the juice is kept hot. In the old type of open clarifier, within a few minutes after filling, it was possible to draw off clear juice from the top draw-off cock, but it usually took an hour or more of settling before the last bit of clear juice could be drawn from the last cock. The reason for this is the fact that the specific gravity of the juice and the solids is about the same and the flocs at the bottom of the tank are competing with the flocs at the top which are trying to settle, and equilibrium almost occurs. Settling slows down and it is then said that settling takes place by compression. That takes time.

In the continuous clarifier of today much the same thing happens. The hot juice remains in process from two to three hours with consequent losses from inversion and decomposition. The speed of settling depends among other things, on the design of the clarifier, the tray area as well as the gallon capacity. With a given flow rate of juice, the smaller the clarifier the less time the juice remains in the clarifier, the lower the loss of sugar from inversion. The more rapid the settling, the more brilliant the juice, the higher the sucrose and purity. The ideal situation therefore, is one in which settling occurs in a matter of minutes instead of in a matter of hours. WE BELIEVE THE POLY-CELL SUBSIDER FULFILLS THIS REQUIREMENT.

The principle behind the design of the Bach Poly-Cell Subsider is based on the fact that fresh sugarcane juice, properly limed and heated to the right temperature will settle about an inch a minute if the flocs are separated into layers. Therefore, if a clarifier could have a multiple of trays instead of the conventional four or five, the mud would not have far to travel on each tray and would settle in a matter of minutes without competition within itself. Of course that is mechanically and economically impossible with the conventional clarifier because of the necessity for some kind of scraping mechanism to remove the mud from each tray. In the Poly-Cell Clarifier this is not the case as there are no scrapers on any of the trays (only in the mud compartment). Each coneslopes downward at a 60 degree angle. The mud slides off the cones by gravity.

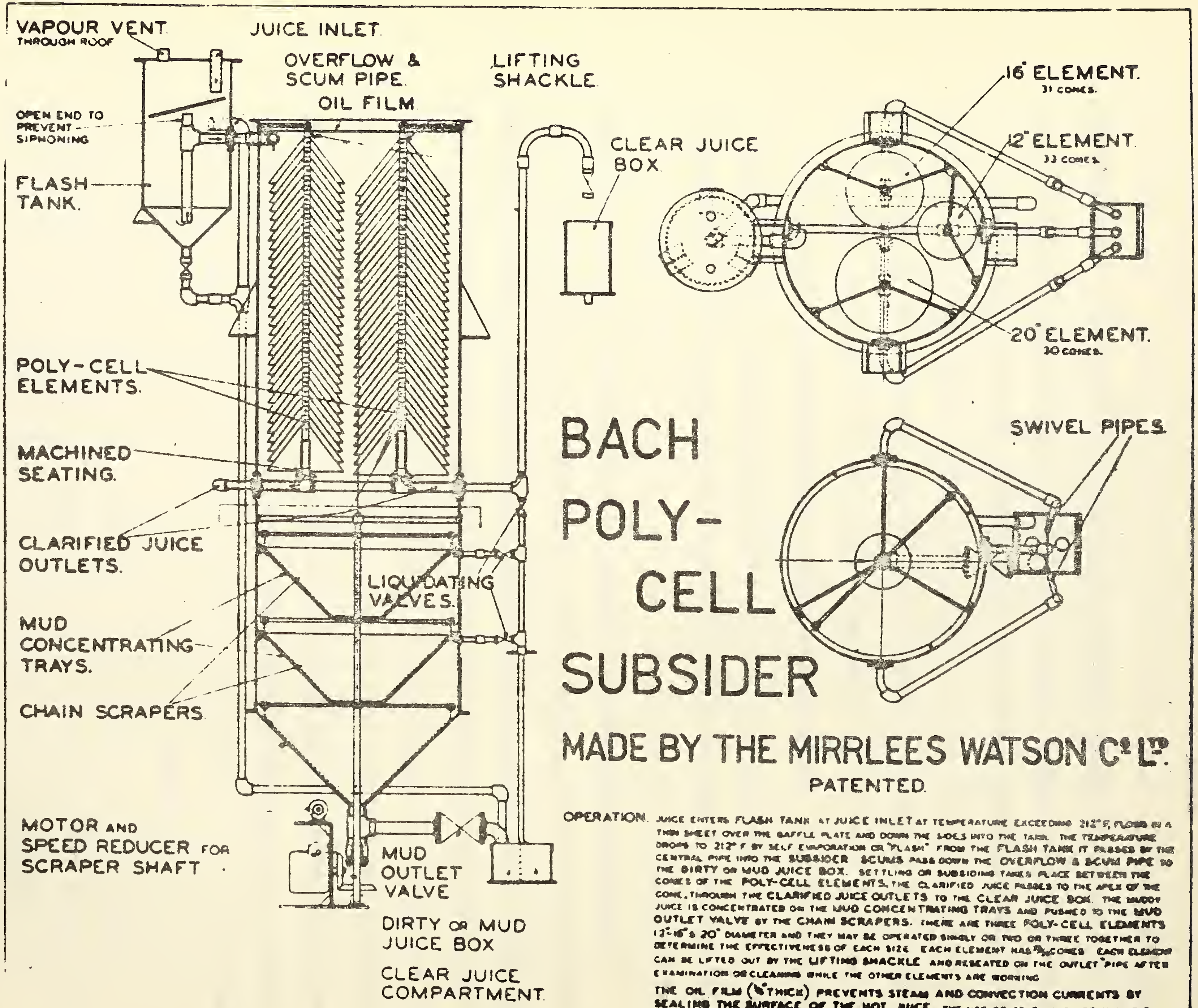
To put it simply, the Poly-Cell Clarifier is just a tank with a 45 degree angle conical bottom having scrapers in the cone to ease the mud to a central draw-off sump. In this tank there is fixed a cylindrical baffle which extends downward to just above where the conical bottom begins. Smaller units need not have this baffle. However, if used the baffle must provide sufficient space to permit the placing of a number of Poly-Cell units between it and the outer wall and leave enough space for the settling mud to fall to the mud compartment. Usually the space between the diameter of the cell cluster and the width of the annular space is about four inches.

Each Poly-Cell unit is made up an inch and a half steel pipe of proper length, closed on the bottom end. At two inch intervals along the length of the pipe, quarter inch holes are drilled in a straight line. Just above each of these holes, cones having a base diameter of varying widths, usually 20 inches and having a 60 degree angle slope are welded or clamped to it to make a leak-proof joint. During operation the clear juice flows through each of these holes and leaves the pipe through a header, or each pipe may have a separate outlet to an outside trough. Since the hole is just under the apex of the cone tray no mud can enter, for to do so it would have to climb up the underside of the cone for about a foot. This would be impossible unless the clarifier filled up with mud a foot or so above the bottom hole.

The sketch you have shows the detail of the cone arrangement, the outlet holes and the pitch of the cones. It also shows the general arrangement of a Poly-Cell Subsider having just three units. This unit was designed for experimental purposes for the College of Tropical Agriculture in Trinidad. It is not a commercial clarifier. On theblackboard is a drawing of a unit we first proposed for Lula Factory but this will be expanded as will be explained later in this paper. The number of units required in any commercial installation depends on the work capacity desired and generally runs as high as twenty-five or thirty. In other words, you may put in as many cells as you have room for. The unit on the blackboard will handle about thirty gallons of filtrate a minute, or 1,800 gallons per hour. I am sorry I do not have enough of these drawings to pass around but you may, if you wish examine it more closely after the meeting.

We intended at first, through the splendid cooperation of Charlie Savoie and Pat Cancienne, to put this identical unit in at Lula for operation this fall. However, we realized it would not be large enough to handle all of their filtrate so we decided to build a larger unit with eight cells instead of three. This unit will handle all of the filtrate from 150 to 160 tons of cane per hour. This unit is now under construction and will be ready for grinding this fall. We will keep accurate account of such items as flow-through, Ph, temperature of incoming and outgoing juice, sucrose and purity in and out, mud height and thickness, etc. The results will be published at a later date.

If the Poly-Cell works on filtrate, it will help to solve a lot of mud problems which are now plagueing Louisiana processors. We already know it will work on mill juice it having already given excellent results in Florida. The juice was heated but not limed as it went into syrup, and yet the overflow from each poly-cell was brilliantly clear and without a trace of bagacillo. It was doing this without supervision to any extent. In fact when I was there there didn't seem to be anybody watching it. If you are interested, we will be happy for you to come over and have a look at it when Lula gets going. Thank you.



BACH POLY-CELL SUBSIDER

MADE BY THE MIRRLEES WATSON C° L^D.

PATENTED.

OPERATION. JUICE ENTERS FLASH TANK AT JUICE INLET AT TEMPERATURE EXCEEDING 212° F, FLOWS IN A THIN SHEET OVER THE BAFFLE PLATE AND DOWN THE SIDES INTO THE TANK. THE TEMPERATURE DROPS TO 212° F BY SELF EVAPORATION OR "FLASH" FROM THE FLASH TANK IT PASSES BY THE CENTRAL PIPE INTO THE SUBSIDER. SCUMS PASS DOWN THE OVERFLOW & SCUM PIPE TO THE DIRTY OR MUD JUICE BOX. SETTLING OR SUBSIDING TAKES PLACE BETWEEN THE CONES OF THE POLY-CELL ELEMENTS, THE CLARIFIED JUICE PASSES TO THE APEX OF THE CONE, THROUGH THE CLARIFIED JUICE OUTLETS TO THE CLEAR JUICE BOX. THE MUDDY JUICE IS CONCENTRATED ON THE MUD CONCENTRATING TRAYS AND PUSHED TO THE MUD OUTLET VALVE BY THE CHAIN SCRAPERS. THERE ARE THREE POLY-CELL ELEMENTS 12"-16" & 20" DIAMETER AND THEY MAY BE OPERATED SINGLY OR TWO OR THREE TOGETHER TO DETERMINE THE EFFECTIVENESS OF EACH SIZE. EACH ELEMENT HAS 33/30 CONES. EACH ELEMENT CAN BE LIFTED OUT BY THE LIFTING SHACKLE AND RESEATED ON THE OUTLET PIPE AFTER EXAMINATION OR CLEANING WHILE THE OTHER ELEMENTS ARE WORKING

THE OIL FILM (⅛" THICK) PREVENTS STEAM AND CONVECTION CURRENTS BY SEALING THE SURFACE OF THE HOT JUICE. THE USE OF OIL FILM IS OPTIONAL WITH BACH POLY-CELL SUBSIDER.

7741

A SUGARCANE CARRIER CONTROL SYSTEM

by
Sidney J. Levet, III

This system is capable of delivering more tons of cane per unit time at the crusher, by more efficient use of the knives and shredder. This is accomplished by regulating, by use of a feedback circuit, the load on these units. Moving the cane from the yard to the mill is the function of the carrier. While on the carrier, the cane is prepared for milling by the knives and the shredder. It is at these stations that trouble is likely to occur. The load on the turbine and motor changes due to the varying amounts of cane being passed. Overloading is a frequent problem. The load on these units changes so quickly that the reaction time of the operator is sometimes not fast enough to prevent a choke. Even if a choke is prevented the wear and tear on the units by repeated overloading is excessive. The other extreme is also expensive, the operator, feating a choke, will underload the units thereby passing less cane. With this system, the load and hence the feed is kept relatively constant and chokes are a thing of the past.

The system is in use presently at Frisco Cane Company's San Francisco factory. The carrier is powered by a steam engine. It was decided that the carrier should have three speeds of operation - stop, slow and fast. The exact rate of carrier movement for the slow and fast speed was determined once the system was in operation. Three speeds were chosen but as many speeds as desired are possible.

The carrier engine's steam supply is controlled by two solenoid valves one 3/4 inch in diameter and the other 1 1/4 inches in diameter. Each valve has a hand valve connected in series for fine speed adjustment. The operation of these values is determined by the load on the knives and shredder, and the level of cane above the crusher.

The three points of control are at the knives, the shredder and the crusher. The knives are powered by a steam turbine and the load is determined by a special DC generator. As the load increases, the speed of the knife shaft decreases. The generator develops a voltage in proportion to the speed of the knift shaft. The voltage developed actuates two special voltage relays. One relay controls the fast speed, the other the slow speed. When both relays are open the carrier is stopped. Since the normal speed of the knife shaft is 600 RPM, at full load, the relay that controls the fast speed is set to close at 600 RPM and to open at 500 RPM which is 120% full load. The relay that controls the slow speed is set to close at 500 RPM and to open at 400 RPM, 150% full load. Below 400 RPM the relays are open and the carrier is stopped. The 100 RPM difference between the drop-out speed and pull-in speed of each relay is such that once the relay is open it gives the turbine time to gather some momentum before closing and the load is applied. In actual operation, this worked to the satisfaction of all concerned. The relays used were built to specifications for this system by Potter and Brumfield. The shredder is powered by a three-phase 440 volt electric motor. The means used to determine the load on this unit was the line current. Two current transformers and two current relays are used. The operating points for the relays are 125% and 145% of full load current and these can be safely handled by the motor. With the motor operating at normal load both relays are closed. As the load increases so does the line current, and when it reaches 125% of full load the current relay connected to the fast speed opens and operation in that speed ceases. If the current increases to 145% of full load, the relay connected to the slow speed opens and stops the carrier. As the load on the motor drops the process is reversed. Just as on the turbine there is a delay between the opening and closing in order to give the motor a chance to build up some momentum before the load is applied. As with the voltage relays, this setup worked with only one minor defect. One of the relays would stick in the open position, but this was due to misalignment in installation. It was corrected and gave no further trouble.

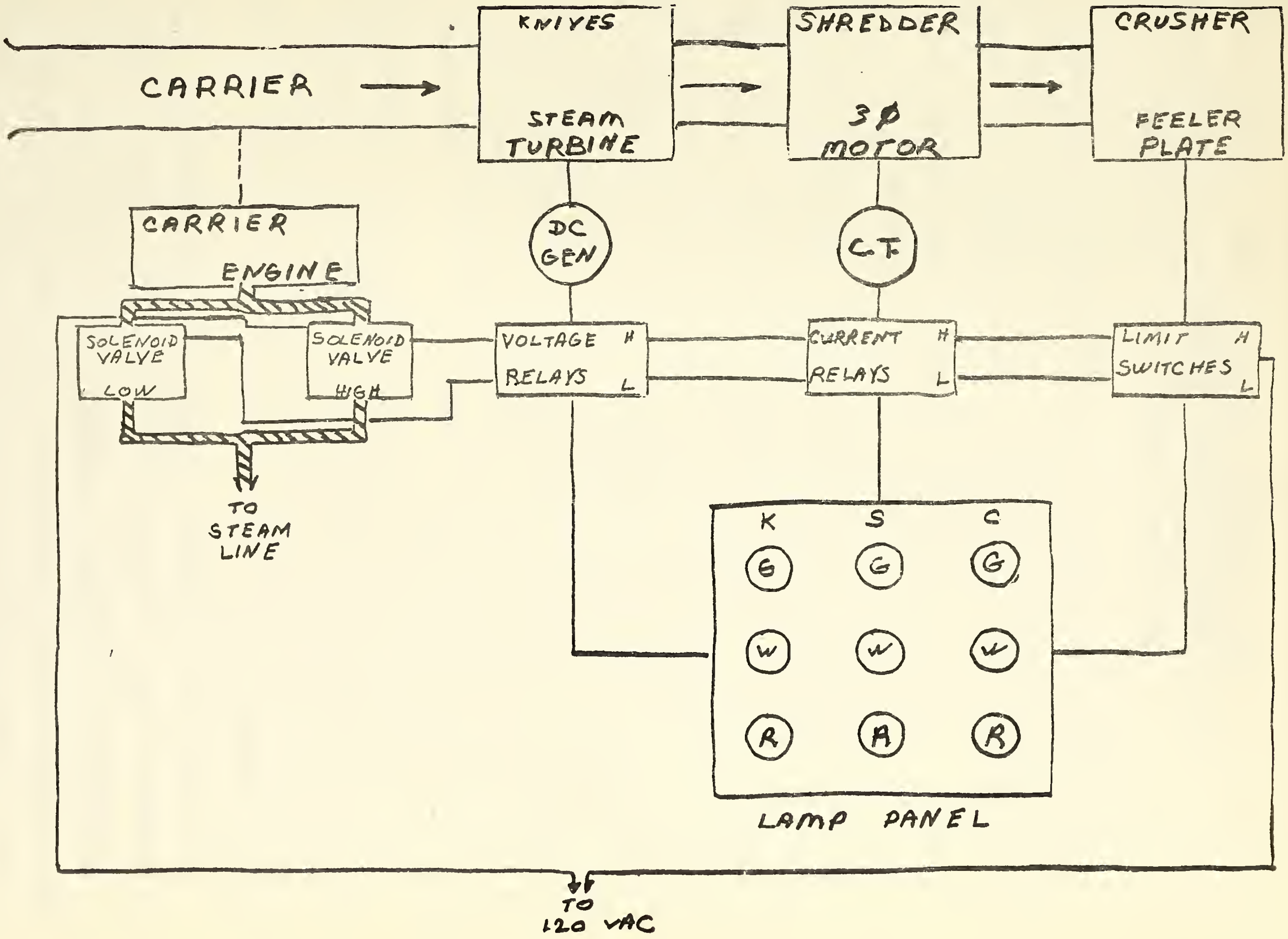
If each of the forementioned units controlled the carrier engine independently of the other, trouble would result. Therefore, the control circuit is wired in series. That is, the unit with the load determines the speed of the carrier engine. One other point is needed in the control system. If the mill has to stop or if there is a choke on the crusher, the supply of cane has to be stopped. This is accomplished by use of a "feeler" plate mounted in the chute above the crusher. Movement of this plate by the level of cane in the chute activates switches, which in series with the other circuits, control the speed of the carrier engine.

The operation of the units is indicated on a monitoring light panel. If the unit is overloaded, a red lamp is lit; if the load is heavy to medium, a white lamp is lit; and if the load is medium to light, a green lamp is lit. This scheme holds true for the shredder and the knives. In the case of the crusher, a red light indicates a full; a white light indicates a half to full chute; and a green light indicates a half to 1/4 chute. In all cases, one red light indicates the carrier is stopped, but for operating in the slow speed three white lamps must be lit. In the fast speed three green lamps must be lit.

Due to the large amount of construction performed at San Francisco last year, complete installation of the unit did not occur until the midpoint of the grinding period. However, two sections were in operation since the beginning - namely, the knife and shredder load sensing units and the lamp panel. It assisted the operator in judging the loads on the units. On one occasion the operator noticed the red lamp on the knives lit, while at the same time another indicating instrument showed no trouble. The engineer was called and he discovered a broken governor spring on the turbine. There were many other times when the panel indicated trouble starting and thereby prevented a choke.

During a period of boiling out the feeler plate was adjusted and the system was made ready. When grinding resumed, the president and general manager, along with the chief engineer and myself, positioned ourselves so as to watch the indicating instrument on the master control panel, the shredder motor ammeter and the lamp panel. The carrier was being operated by manual control. Shortly after starting the watch, a large amount of cane fell into the carrier. As it approached the knives the RPM meter showed the speed of the knives dropping. At 500 RPM, the solenoid valve that would control the high speed of the carrier engine closed. The cane was then reaching the shredder. The line current rose up to and passed the 125% level, then passed the 145% level and at this point the valve for slow speed operation closed. Still the carrier engine ran. The operator finally reacted and shut off the engine. The line current at this point reached 500 amperes. The chief engineer quickly cut out the manual control and cut in the automatic control. The current on the motor fell, the small valve opened, the carrier was automated.

BLOCK DIAGRAM OF SYSTEM



S. J. LEVET III

A NEW METHOD FOR ECONOMIC UTILIZATION OF BAGASSE

by
John R. Shattuck, President
NATIONAL BAGASSE PRODUCTS CORPORATION
1120 Commerce Building
New Orleans, Louisiana

It is not only a great honor to be invited to speak to the Louisiana Division of the Sugar Industry Technicians but it is also quite a challenge to me to find myself speaking for the first time to experts in my own field of endeavour. In previous addresses to Chambers of Commerce, Chemurgists and television audiences in Cuba I have been able to avoid discussion of how we make our FIBRON product line and to deal primarily with glamorization of the products themselves and the problems of developing a new industry from what some have labeled a "crackpot idea" in the past. Those audiences had little or no knowledge of sugar or bagasse technology and were not, therefore, in a position to ask the kind of embarrassing questions I have been warned to expect from my peers in the sugar industry. I shall, therefore, do my best in accepting this welcome challenge to answer most of your questions in my own way during this speech so that I will not be called upon to answer too many of them in your way afterwards.

Let me start off by trying to answer the question which is always put to me first by most people who are interested in our development. "What made you decide to get into the business of using bagasse in its dry state to make a new kind of board products?"

My interest in the utilization of bagasse began back in 1952 when I was vice president in charge of operations for a large sugar company with production facilities in Cuba. Bagasse was used as fuel for the sugar mill and we had extra boilers to burn up the excess which was not required for fuel. In spite of all this burning capacity, we still could not burn up all the bagasse and incurred a substantial annual expense in getting rid of the excess by hauling it away. As a result it was quite clear that any use of bagasse which would pay us enough to offset the hauling away cost was worthwhile, provided that the capital investment was not too large. I, therefore, searched for such a use with a relatively small capital investment in mind. It was already quite clear at that time that good craft paper and cardboard could be made from bagasse and we tried to interest large pulp and paper companies in locating at our sugar mill.

A successful operation of this type already existed in Peru and others were in the planning stage for other countries. It is, in fact, true that as early as the mid 1800's newspapers were printed experimentally on bagasse newsprint in the United States. Although it turned out that we had neither enough money nor enough water to enter the industry, it is interesting to note in passing that several pulp and paper mills and one newsprint mill, all using bagasse, did spring up in Cuba later and relatively new bagasse paper mills are now in operation in Mexico, Colombia, Puerto Rico and Louisiana.

Bagasse was also used successfully at the time in the manufacture of excellent insulation board from bagasse pulp by The Celotex Corporation in Louisiana and by local concerns in Hawaii, Formosa and Australia. By the same process, with some addition, this insulation board was also turned into wet process hardboard, similar to that made by the Masonite process from exploded wood fibers. The hardboard phase of the business was abandoned in this country as being uneconomic and because of the apparent impossibility of matching the quality of hardboard made from wood fiber, but as you know, wet process bagasse insulation board continues to have superior insulating and acoustical properties because of the basic nature of the bagasse fiber. None of those processes were practical for us, however, because they all required more water and capital than we had available.

While we did manage to sell some fine bagasse to cattle feed manufacturers for utilization as a bulk carrier in cattle feed and were familiar with its use as an excellent litter for chickens and bedding for animals, Cuban farmers did not bother to feed and bed their cattle or feed their chickens in those days and the freight charges were too high to permit economic export to the United States. While bagasse had many other potential laboratory tested uses such as a support for mushroom culture, a soil conditioner, a mulch material, as a conditioner for sand in foundry operations, as an extender for adhesives, as an additive to oil well drilling muds, as charcoal, as a fiber for spinning into yarn, as a substitute for tobacco in cigarettes, and as a lightweight aggregate in concrete blocks, none of these suited the economic requirements of the Cuban economy and had to be abandoned from a practical business standpoint.

Over a period of a year or so we learned a great deal about bagasse but unfortunately most of what we learned was what not to do with it. There had been many failures which hurt the prestige of bagasse over a period of many years, dating back in the personal experience of Cuban friends, who presently form part of National Bagasse Products Corporation, to 1925, when they made a beautiful sheer substitute for the best silk stockings. This industry failed to prosper only because the ladies of Cuba who saw the merit of paying $11.25 per pair for superior hosiery were rather hard to track down.

Having been obliged to abandon every conventional use for bagasse, it became necessary to turn to dreaming of entirely new uses. Only a few years before, European lumber interests, faced by a shortage of natural lumber and plywood, had embarked upon a program of binding waste wood particles together, with synthetic resins under heat and pressure and making a substitute for lumber. They were followed shortly by a linen textile manufacturer who tried the same thing successfully with flax shives left over as a waste from his textile operation in Belgium. This was an entire new industry which was still in the money losing stage but, according to technical experts, appeared to have an excellent future if any way could be found to control the length, thickness and width of each waste particle used so that a completely homogenous board could be made from particles of equal dimensions. It occurred to me that bagasse had a natural advantage for use in such a product since each bagasse fiber already had width and thickness characteristics almost identical to every other bagasse fiber and only the length had to be controlled to produce the desired mass of fibers of equal dimensions. There was, however, one characteristic of bagasse standing in the way - a characteristic which led everyone of the engineering experts in the field to discard bagasse completely as a usable raw material for particle board. This was the fact that bagasse is comprised of excellent fiber and a soft spongy material called pith which clings tenaciously to the fiber and could only be removed commercially by boiling it off in water. Leaving this problem aside for the moment, which is my customary approach to problems I cannot solve immediately, we made up sample boards and found them satisfactory in every respect but one. When they were exposed to moisture they swelled up like sofa pillows, exactly as they were supposed to do with pith in them. The only solutions to this were to add an exceptionally large amount of expensive resin to the mixture or find a way to remove the pith without boiling the life out of the fiber. By dint of what I considered to be logic and what everyone else considered to be mulishness or insanity, I finally determined upon a way to accomplish this in theory and finally recommended that my company should go ahead with the plant whether or not we could remove the pith completely since the economics and the politics in that particular county, where there was no wood, would permit the use of a high resin content if necessary. My superiors, with justificable conservatism, characteristic of the sugar industry at the time, differed considerably with my recommendations to proceed and I had no choice but to proceed on my own with the invaluable technical, financial and - above all - moral support of a highly successful machinery manufacturer and wet process board plant expert whose 50 years experience made him agree that the possibilities were excellent. We obtained the financial backing of the Cuban Government and brave friends. Two years later when we saw the first board emerge from the press we knew we had an excellent product. This was only the beginning and now that others have decided to copy the process and Fidel Castro is bragging about his new industry, we are most happy to admit that our early triumph is, only two years later, completely obsolete because of new developments in the market and in basic board making techniques.

On May 18 of this year, the new automated board plant of National Bagasse Products Corporation in Vacherie, Louisiana was formally dedicated and has for the past week been operating round the clock every day to fill orders for Fibron board products. For those few of us who were associated together in the earlier development of this industry in Cuba, beginning in 1955, it was no surprise at all that the very first day of operations saw board of acceptable quality emerging from the plant. But to certain experts on Wall Street and to some of our long haired engineering friends who have taken some satisfaction at times during the past year in spreading rumors that our whole technical concept was erroneous we trust that it has proved to be a considerable surprise. Among the more humorous evidences of skepticism regarding our efforts which I have received in recent months was a little jingle which I think you will enjoy and which you may be able to use once in a while when the right occasion arises:

Somebody said that it couldn't be done,
but he with a smirk replied,
he would never say that it couldn't be done,
leastwise not till he tried.

So he set right in with a prize of a grin,
by golly, he went right to it.
He tackled that thing that couldn't be done
and - by God - he couldn't do it.

In all seriousness, a general skepticism, regarding the potential for utilization of bagasse, exists in the form of numerous learned articles on the subject, residing in the archives of public, institutional, private and Government libraries. One of these articles says, for example, that pith can only be removed from bagasse by a washing or boiling process. Another expert has stated that bagasse, and Louisiana bagasse in particular, contains a high silica content within the fiber itself which cannot be removed by any process. Another states categorically that dry process board cannot be made from bagasse because the residual sugars crystallize under the pressing temperatures used and destroy the board surface; it has also been stated in several articles that bagasse fiber absorbs as much moisture that any board made from it will swell up like a balloon and fall apart; also that bagasse fiber is excessively combustible and will make a board that will be consumed by flash fire if flame ever touches it. The sheer weight of this authoritative published opinion is enough to discourage most prospective developers or potential supporters of any bagasse project and has, in fact, for years been responsible in great part for the failure of industrialists around the world to utilize one of the world's most available supplies of useful fiber.

It is about time that the myths written by theoretical experts about the economic utilization of bagasse should be exploded and I am most happy that we here in Louisiana, where bagasse was first utilized successfully on a commercial scale over forty years ago in a wet pulping process, can now take the lead in exploding the myths merely by showing those who are interested a process and products which make a great part of the published expert opinion on bagasse obsolete. To emphasize the point with a few facts, I should like to tell you a few things about our process and our products which refute the expert opinion outlined above. Contrary to existing opinions, without the application of any water to the bagasse, our process does, in fact, remove 96% of the pith and silica contained in the bagasse received from the sugar mills and we are convinced that these elements must be removed to achieve a good board economically in most locations. Secondly, the fibers remaining after removal of pith and dirt from the bagasse are so free of residual sugars that they can be put into a wet cement mix without inhibiting the setting of the cement at all. As you probably know even the smallest amount of sugar added to a cement mixer will prevent the cement mix from setting for hours. In the third place, the board surface created by these fibers is so smooth than an artificial wood grain can be printed directly on the board surface to duplicate the appearance of natural walnut or any other exotic wood grain. This could not be done if there were any sugar or pith remaining in our bagasse fiber. Our Fibron board products swell less from absorption of moisture than any competitive board product or competitive natural wood products in the market. Finally, none of our Fibron board products will support a flame after the flame source is removed and you may hold a piece of 1/2" Fibron board flat in your hand and run a blow torch slowly across the top without feeling any warmth on your hand and without setting the board on fire.

Our system for producing clean usable fiber from bagasse by a wholly dry process must, of course, be maintained confidential in spite of the fact that it is protected by a "patent applied for." I can tell you, however, why a board made from cleaned bagasse fiber makes a product of exceptionally high quality when compared with boards made from wood wastes or specially prepared wood flakes as our 65 competitors in the United States are doing. The secrets of making a high quality board lie in the ability to produce a board with good strength combined with relatively light weight, balanced structure to prevent warping, resistance to swelling as a result of moisture absorption, a smooth surface to permit veneering with the thinnest wood, plastic or paper laminates and painting with a minimum of expense. The answers to most of these desirable characteristics of a board lie in the basic nature of the fibers or flakes themselves from which the board is made.

Each bagasse fiber has a uniform thickness and a uniform width. The only dimension which one must control is the length in order to have absolute control over particle size. Theoretically the ideal board product is made of particles or fibers which are all of exactly the same dimensions because this will result in a completely homogenous product. In order to achieve high strength these particles should be long and narrow and frayed on the ends so that they will felt across one another and lock together at the ends with as little artifical binder as possible. You can see how the prepared bagasse fiber I have here binds itself together when I squeeze it in my hand. Having seen this simple demonstration now imagine that you are in a forest with the ambition of producing a wood particle board from the vast wood supply available right here in the South. As qualified engineers and technologists you are all capable of picturing the process you must go through in order to duplicate the bagasse fiber you have just seen squeezed by hand pressure into a ball. All you have to do is get the trees to your factory and convert the logs into fibers of equal thickness, width and length with frayed ends in order to achieve the same result. And while you are designing the equipment for the job, remember to make the proper allowances for the fact that the tree ahead of you is a soft pine, that the one on the left is a highly absorbent gum, and the one on your right is a tough oak. If, in fact, any of you can do the job accurately at any reasonable cost, the doors of every lumber company in the world are wide open to you.

When we put the bales of bagasse onto a conveyer leading into our plant they move through a bale breaker into a maze of chopping and cleaning machines, feeding bins and classifying units, ducts, cyclones, and drying units which send dry fiber to the board production line, short coarse reject fibers to a disposal system, pure fiberless bagasse pith to the furnace, and Louisiana silica and clay back onto the ground. After the wires are removed from the bagasse bales, this whole process is handled automatically and watched over by two men at separate control panels in two buildings who do nothing but watch dials and lights for eight hours at a time; theoretically that is. Actually whenever a loud alarm goes off or red lights start to blink their efforts are suddenly supplemented by those of a foreman, two Vice Presidents and occasionally the Vacherie Volunteer Fire Department. Until a week or so ago this was the normal routine rather than the exception.

The dried bagasse fiber is then conveyed periodically by air to a blender in a third building which applies synthetic chemical binders and other elements to them upon the order of an automatic electrical system. The coated fibers then proceed without further instructions to a mat forming machine which moves back and forth on rails to form an air felted mat on a movable steel belt. This forming system has the convenient attribute of making up for our failure to control fiber length exactly by laying the long fibers in the center of the mat and the shorter ones graduated towards both surfaces so that the short ones appear on both surfaces to create very smooth board surfaces. Since the smaller surface particles draw a higher percentage of chemical binders than the longer ones this also results in a higher resin content and higher density on the board surfaces to provide excellent board balance, surface resistance, and smoothness. Since these characteristics are governed by the nature of the fiber and the patented forming system the same characteristics result in boards of very light (10 lbs. per cubic foot) or of very high (60 lbs. per cubic foot) density.

This mat then moves on the moving steel belt into a hot water heated press. The press is controlled carefully by the sole machine operator in the building and when the board is set and the press is opened several things happen. The finished board moves out and is automatically trimmed out into two pieces which can be handled and deposited automatically onto an automatic stacking device. The opening of the press simultaneously starts the whole system all over again and as another mat moves into the press more fiber flows over into the system from the adjacent building.

The boards emerging from the press are stored for several days and then fed into an automatic finishing line which sands the boards to close thickness tolerances, trims all four edges to exact dimensions and cuts the finished boards into the combinations of sizes desired just prior to shipment to the markets.

Now that I have told you all of our technical secrets let me close by telling you briefly how we have approached the problem of product selection and marketing. Whenever one enters our office he is certain to find one of us, either the Sales Manager or the Production Manager, myself or even one of the secretaries in what appears to be a trance staring at the ceiling. It always scares me a little when I see one of our people acting in this way because I have spent some time in a room with Fidel Castro when he struck such a pose and know that it is likely to result in some shockingly positive idea or action or perhaps even execution. Nevertheless a new industry is dependent on new ideas and their execution, so we put a premium on such creative trances.

In the course of determining what products to make and how to sell them we have sat down with Presidents or shop foremen of many many companies in at least 50 different industries to see just what is required for the centerboard of a boat, a highway sign, a prefabricated one piece wall for a house, a radio or television case, a solid core soundproof door, a ping pong table, a soft drink crate and hundreds of other items. We have found invariably that every user knows exactly the characteristics he requires and that there is no product in the market that gives him these exact characteristics.

Fortunately, we found in at least 90% of the cases, before we completed our plant design that our process could, with some alteration, make what these owners and foremen wanted. During the plant construction stage we have had time to perfect a wide variety of such products for which there are extensive markets and have only had to make a few hundred changes in plant design to permit it.

One large industry in this country is the solid core flush door industry which has traditionally made cores of solid wood strips laminated together and sanded to close tolerances. We have developed a one piece core for these doors which results in a lighter, more soundproof door with excellent insulation characteristics for use as an exterior door. This door meets Government specifications for solid wood core doors and costs much less to produce. As a result, our factory will operate at least one-third of the time on a 24 hour per day, seven day per week basis for the next few months making these thick cores to meet a large order file for the door and partition industries. As yet there is not competition in this field from other boards.

In recent years a very large demand has developed in this county for imported wood grained hardwood plywood. The natural wood grain is eradicated from the hardwood plywood and a new artificial wood grain, photographed from the highest priced woods is imparted to the surface. It has been generally conceded that this process cannot be applied economically to fir plywood or wood particle or flakeboard for a variety of technical reasons and that fabricators must rely on irregular shipments of imported hardwood plywood. We took the attitude that what applied to plywood and wood flakeboard did not apply to bagasse board and were able to persuade certain coating experts to help us develop the right formulation to permit wood grain printing on Fibron panels. After a year and one-half of concerted effort, all the experts, but one, quit staring at the ceiling and gave up, having decided they had spent enough of their time and money on a hopeless task. The other one kept working bullheadedly and a few months ago took us to a wood grain printing plant for a demonstration on our board. The board went into one end of the production line and came out the other looking exactly like a piece of solid walnut. This product which presently has no domestic competition will be used for table tops, all types of furniture, cabinet doors and wall paneling. We have developed a large demand for this alcohol, acid and scratch resistant product as well and expect it to move in large volume through our large national distributors, Georgia-Pacific Plywood Corporation and The Celotex Corporation who have contracted to move approximately half of our production of all products through their very extensive national sales outlets. Both of these companies have found that our Fibron panel boards of several different types serve to fill out their product lines and stimulate their sales volume rather than cutting into sales of their own products.

The answer then to the important question of how to compete with the giants in the board industry is that we plan to grow to some stature and earn our bread and butter by providing what the market wants, but does not have, without competing directly with existing products. When and if we run out of ideas we will have to enter the competitive melee more directly producing large volumes of standard boards which sell primarily on a price basis. When and if such become the case we have no doubt that we can gain a substantial share of the market on a quality basis and have few worries about competing on a price basis until some genius finds out how to make bagasse out of wood economically.

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